SPACE THEORY AND STRATEGY:
WAR FROM THE HIGH GROUND DOWN

BY

ANGELO FERNANDEZ

A THESIS PRESENTED TO THE FACULTY OF

THE SCHOOL OF ADVANCED AIR AND SPACE STUDIES

FOR COMPLETION OF GRADUATION REQUIREMENTS

SCHOOL OF ADVANCED AIR AND SPACE STUDIES

AIR UNIVERSITY

MAXWELL AIR FORCE BASE, ALABAMA

JUNE 2016

APPROVAL

The undersigned certify that this thesis meets master's-level standards of research, argumentation, and expression.

_____

COLONEL M.V. "COYOTE" SMITH (Date)

_____

COLONEL TIMOTHY CULLEN (Date)

DISCLAIMER

The conclusions and opinions expressed in this document are those of the author. They do not reflect the official position of the US Government, Department of Defense, the United States Air Force, or Air University.

ABOUT THE AUTHOR

Major Angelo Fernandez was a 2003 United States Air Force Academy graduate, where he majored in management. His 13-year active duty Air Force career includes staff experience at 14th Air Force and space operations experience with various weapon systems. Major Fernandez's operational experience includes force enhancement missions with the Global Positioning System at 2nd Space Operations Squadron and space control missions at 4th Space Control Squadron and 17th Expeditionary Space Control Squadron.

ACKNOWLEDGMENTS

I would like to acknowledge several people without whose support and help I would never have gotten off the ground with this study. To the ACSC and SAASS professors who instructed and developed a robust curriculum shaping my mind on national security issues, thank you for an extraordinary learning experience over the last two years. To my thesis advisor, Colonel M.V. "Coyote" Smith, thank you for the advice and patience during this journey. I truly appreciate your continuous support during my thesis development. To my thesis reader, Colonel Timothy Cullen, I would like to express my gratitude for the insightful suggestions to this work. To the ultimate sounding board, Professor James Kiras, thank you for the profound suggestions at a critical juncture of this thesis. Finally, to my classmates over the last two years, thank you for sharing your stories because I have learned so much from you. I know of no better learning atmosphere to expand one's perspective and horizons.

Most importantly, I want to express my sincere appreciation to my family. To my bride, your endless love and support is beyond my wildest dreams. Thank you for supporting me during this demanding educational experience. I love you with all my heart. To my kids, every day you find a way to make me laugh. Thank you for the memories and I can not wait to make more.

ABSTRACT

This thesis provides a theoretical foundation for space warfare, develops a space theory based on irregular warfare principles, and applies the theory towards a US space strategy. Space warfare is a subset to general war theory because space actions are merely political extensions and can be violent. An irregular space warfare theory's primary purpose is to ensure survivable space-derived services. The proposed theory revolves around complicating an adversary's targeting calculus by creating an identification challenge. Robust user equipment, hosted payloads, and covert small satellites are some of the means to assist in the task. Ultimately, the United States is in a prime position to employ an irregular space strategy because of its international leadership role, the number of its allies and partners, and its existing orbital architectures. The thesis delivers a strategy for US strategists contemplating how to deter, deny, and defeat adversary attacks against US and allied space systems.

CONTENTS

INTRODUCTION

Outer space is of vital importance to the United States. It provides the ultimate high ground for conducting operations to enhance national security, prestige, and wealth.[1] Traditional ways of thinking about outer space are increasingly outdated. Once viewed as a pristine celestial sanctuary devoid of humankind's debacles, outer space is now congested, contested, and competitive.[2] A vast frontier with few laws, the international community has failed to expand relevant norms beyond the Outer Space Treaty of 1967. Cold War paradigms linger, grossly exaggerating the role of spacecraft as part of a hair-triggered nuclear strike system only targeted in a first-strike strategy.

There is a void in current space theory. Space theorist Everett Dolman utilizes a geopolitics model and proposes a theory to control Earth from the strategic chokepoints in the ultimate high ground.[3] This proposition fails to account for the diverse and undesirable reactions among the international community. Space theorist John Klein uses analogies equating the space domain to the sea, thereby transmuting maritime strategies into space strategy.[4] Such an approach does not account sufficiently for many of the unique characteristics of space. Space theorist Ambassador Roger Harrison leverages a layered deterrence framework to balance risks in space.[5] The difficulties of attributing space attacks can paralyze decision-makers' response on whom to retaliate against when deterrence fails. The theories above sample

1. Security, prestige, and wealth is a contemporization of Thucydides famous tryptic, "fear, honor, and interest," which he identified as the motives for political behavior. See *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War*, ed. Robert B. Strassler (New York, NY: Free Press, 1996), 43.
2. Department of Defense and Office of the Director of National Intelligence, *National Security Space Strategy: Unclassified Summary* (Washington, DC: Secretary of Defense and Director of National Intelligence, January 2011), 1-3.
3. Everett C. Dolman, *Astropolitik: Classic Geopolitics in the Space Age (*London: Frank Cass, 2002), 4-6.
4. John J. Klein, *Space Warfare: Strategy, Principles and Policy* (New York, NY: Routledge, 2006), 151-161.
5. Roger G. Harrison, Deron R. Jackson, and Collins G. Shackelford, "Space Deterrence: The Delicate Balance of Risk," *Space and Defense* 3, no. 1 (Summer 2009): 17-26, http://www.usafa.edu/df/dfe/dfer/centers/ecsds/docs/Space_and_Defense_3_1.pdf.

a range of current space thought. The existing gap in current space theory can be filled, in part, with an irregular warfare perspective.

This thesis uses an irregular warfare lens to develop a theory of space warfare and formulate a US space strategy. The objective of this work is twofold. First, it paves the theoretical foundation for space warfare. Bridging space warfare to general war theory allows one to extrapolate irregular warfare principles and apply them in outer space. Second, this thesis formulates an irregular US space strategy in a quest for any revelations to improve the US National Security Space Strategy. Current contextual realities present challenges and opportunities for US leaders. Approaching space from an irregular warfare lens may yield a more advantageous strategy to deter, deny, and defeat adversary attacks against US and allied space systems.

The scope of this research is limited to the space architecture. National space architectures include space, ground, user, and link segments. By focusing only on the space architecture, this thesis is somewhat limited because it will not conduct a comprehensive examination of all potential options required to increase the resiliency of America's fighting force. This paper excludes options for divesting from space reliance by expanding redundancies in other operating environments. This is only to provide some boundaries to the research.

Below provides a preview of the thesis' argument and follows with a background on four contextual realities in space: congestion in orbits, an emerging small satellite industry, developing counterspace strategies, and nations' reliance on space.

Preview of the Argument

Carl von Clausewitz developed one of the most philosophically sound theory on war. He described war as a mixture of politics, violence, and chance.[6] Traditional forms of warfare such as land, sea, and air reside underneath Clausewitz's general theory of war. Space warfare also belongs underneath his theory of war. Chapters 1 and 2 pave the theoretical foundation for this case.

6. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 89.

What is the appropriate framework to bound actions in space? Chapter 1 argues human endeavors in space are merely extensions of politics. This chapter links actions in space to political objectives through a historical analysis of US space activities. This link is critical to establish the connection between politics and operations in the space environment, and by that regard violence employed in space is based on political purpose. US space strategy must start with US space policy. Desired objectives are adjusted over time; yet, a historical examination of US space policy reveals three common themes. The US enduring political aims, regardless of the presidential administration, focuses on maintaining US freedom of action, seeking ways to cooperate with other space actors, and controlling space when required.

Chapter 2 argues actions in space can be violent. The term space warfare is meaningless if disconnected from politics and violence. War is an extension of policy through violent means.[7] Therefore, an understanding of war must clarify the meaning and application of violence. Modern warfare challenges the notion that violence is purely limited to the death of humans. Violence intends to harm, disable, damage, or destroy an intended target. The target of violence is typically people but can also include objects such as unmanned aircraft, nuclear weapon construction sites, or satellites. In space, there are three methods of violence: force, energy, and weaponized code. The interpretation of violence in space, however, differs from traditional domains because it is less physical, less emotional, and less symbolic. Violence is no longer limited to Earth. Actors in the international system can use violence in outer space as a tool to achieve political and military objectives.

Chapters 1 and 2 establish the theoretical foundation for space warfare by linking politics and violence to actions in space. Space warfare requires a theory to guide thought. Chapter 3 searches irregular warfare for principles and then Chapter 4 applies those concepts to a space warfare theory.

Chapter 3 conceptualizes the nature, character, and means of irregular warfare. Theoretically, irregular warfare revolves around the core problem of violence employed under disguise or concealment. The Prussian theorist, Carl von Clausewitz, explains that actors' nature in war tends to employ violence in

7. Ibid., 87.

a limited versus absolute fashion because of fog, friction, and uncertainty.[8] Mao unveils the characteristics of irregular warfare by using direct and indirect forces to concentrate and disperse simultaneously, thereby creating an identification problem for adversaries; thus, preventing the annihilation of its weaker foe.[9] Kalyvas and Simpson drive home the means available to irregular warfare practitioners. Kalyvas addresses the core identification problem in irregular warfare by centering violence as a function of control.[10] Simpson highlights the value and difficulties of a strategic narrative when engaged in an irregular fight.[11] The irregular warfare concepts of identification, use of guerrilla forces, and strategic communication emerge from the chapter as concepts to inform the development of space strategy.

Chapter 4 extrapolates irregular warfare concepts to assist in formulating a space warfare theory and develop a US space strategy. The space theory presented argues that the nature of space warfare will be limited. Based on this deduction, the character of irregular space warfare will revolve around identification. A belligerent attempting to attack an enemy's space systems needs to identify which systems to target. An actor who complicates an adversary's targeting calculus can ensure survivable space-derived services. Covert small satellites, hosted payloads, and robust user equipment are some of the means to create guerrillas in space.

The United States is in an ideal position to leverage an irregular space strategy. As the world leader who helped develop the existing rules-based international order, the United States can shape a more conducive international norm in space.[12] A norm that constrains space attacks to highly selective, temporary, and reversible means reinforces the restraint in space while preserving the environment for future uses. Establishing new space rules of warfare recognizes the current contextual realities. If the United States fields

8. Ibid., 80, 84-85.
9. Mao Tse-Tung, "On protracted warfare," *Selected Works of Mao Tse-Tung (Beijing: Foreign Language Press, 1967)*, 219-222.
10. Stathis N. Kalyvas, *The Logic of Violence in Civil War* (New York, NY: Cambridge University Press, 2009), 12.
11. Emile Simpson, *War from the Ground Up: Twenty-First-Century Combat as Politics* (New York, NY: Oxford University Press, 2013), 203-206.
12. G. John Ikenberry, *Liberal Leviathan: The Origins, Crisis, and Transformation of the American World Order* (Princeton, NJ: Princeton University Press, 2011), xi.

guerrillas-in-space capabilities, the United States could still achieve the three enduring political objectives and defend US and allied space-derived services if attacked.

Chapter 5 concludes with a complete summary of the thesis and assesses the implications of a potential US irregular space strategy. Juxtaposing the US National Security Space Strategy approaches to an irregular space strategy reveals the comprehensiveness of the current US National Security Space Strategy. Current national documents capture concepts such as dispersing satellites and hosted payloads developed in Chapter 4. However, three considerations for US strategists contemplating how to deter, deny, and defeat adversary attacks against US and allied space systems emerge.

In sum, Chapters 1 and 2 provide a theoretical foundation for space warfare. Additionally, Chapter 1 identifies the three enduring political objectives of the United States across presidential administrations. Chapter 2 clarifies the three forms of violence in space. Chapter 3 explores irregular warfare concepts to understand the nature, character, and means of weaker belligerents in war. Chapter 4 assumes satellites are the weaker contestant in space warfare and applies an irregular warfare lens to overcome contested environments. Chapter 5 summarizes the thesis and provides a short analysis on US National Security Space Strategy. The implications of an irregular space warfare strategy suggest the United States is in a prime position to deter, deny, and defeat adversary attacks against US and allied space systems. The following paragraphs provide four contextual realities to orient strategists to the space domain before proceeding onto the thesis.

Background on Contextual Observations in Space

There are four developing contextual observations opening an avenue for an unorthodox approach to space strategy:

1. *Congested orbits* increasing risks of generating orbital debris
2. Emerging *small satellite industry* with potential dedicated launch
3. Evolving comprehensive *counterspace strategies*
4. Modern societies and armed forces with increasing *reliance on military and non-military space assets*

Environmental hazards such as orbital debris increase the risks for cascading collisions rendering entire orbits unusable. An emerging small satellite commercial industry combined with promising space lift developments suggest a dramatic increase of satellite vehicles in the near future. Increases in the satellite population and the growing potential for orbital collisions are not the only changes occurring in outer space. Counterspace weapons are proliferating, along with strategies focused on negating the advantages a nation gains from space-derived services.[13] US reliance on space operations to project power globally makes it especially susceptible to counterspace threats. On the surface, it may appear the United States will be the only nation impacted by counterspace activity. This misperception does not align, however, with the fact military, civil, and commercial space capabilities intertwine into the fabric of modern societies. Certain kinetic attacks on space systems that create space debris could have unforeseen second and third order effects denying all nations free access to space. Such an act could ruin space as a global commons for all. These contextual changes deserve additional elaboration.

First, environmental hazards in space are increasing. Spacecraft aggregate in key orbits and remain for decades—long after their designed end-of-life. Nations and commercial companies prize Low Earth Orbits and Geosynchronous Orbits for their orbital advantages. This attracts satellite traffic into these prime locations, but comes with the risk of overcrowding and collisions. Envision an orbit as a near-circular racetrack and satellites as racecars. As additional cars enter the racetrack, the chances of collision magnify with the growing traffic congestion and any collision can cause a cascading effect leading to multiple car pileups. This is called the Kessler's Syndrome in space. It describes a scenario where the density of objects is high enough to cause a cascading effect of collisions potentially rendering space activities in specific orbital ranges unfeasible for generations.[14]

---

13. G. John Ikenberry, *Liberal Leviathan: The Origins, Crisis, and Transformation of the American World Order* (Princeton, NJ: Princeton University Press, 2011), xi.
Secretary of Defense, 24 April 2014), 32.

14. Donald J. Kessler and Burton G. Cour-Palais, "Collision frequency of artificial satellites: The creation of a debris belt." *Journal of Geophysical Research: Space Physics* 83, no. A6 (1978): 2637-2646, http://adsabs.harvard.edu/abs/1978JGR....83.2637K.

The creation of additional debris occurs from intentional and unintentional collisions. In 2007, China conducted an Anti-Satellite (ASAT) test deliberately destroying one of its defunct weather satellites. The destruction created a massive debris field of over 3,000 pieces.[15] One year later, a defunct Russian satellite collided with a commercial communications satellite generating an estimated 1,500 pieces of space debris.[16] Before these two events, DoD tracked approximately 14,000 man-made objects in orbit, of which 1,100 were active satellites.[17] A lack of rules or norms in this frontier leaves open the option to test and employ space weapons irresponsibly that leave debris in their wake. Additionally, simple rules of the road governing which satellite operator is responsible for maneuvering out-of-the-way from an impending collision does not exist; assuming an operator calculates a conjunction warning in advance. The potential for Kessler's Syndrome becoming a reality nears as new objects enter key orbits, older objects remain in space for decades, and debris mounts from intentional and unintentional collisions.

The second contextual observation is that more satellites and launchers are going into space. This is predicated on ever-advancing technology that now makes such commercial space industries profitable. By the 2000s, standardized small satellite frameworks emerged, and dramatic improvements in satellite components sparked a revolution in small satellite production. Seventy-five nanosatellites launched between 2003 and 2013. In a three-month period from November 2013 to January 2014, 94 nanosatellites launched. Five-year forecasts, at the time of this writing estimate, predicts an additional 1,000 nanosatellites to be launched by 2019.[18] Small satellites perform a variety of mission areas including satellite "swarm formations," hosted payloads, and future developments exploring sub-one-meter resolution with optical and

15. Department of Defense and Office of the Director of National Intelligence, *National Security Space Strategy: Unclassified Summary*, 2.
16. Ibid., 2.
17. Ibid., 1.
18. Technology Quarterly Q2 2014, "Nanosats are go!," *Economist*, 7 June 2014, http://www.economist.com/news/technology-quarterly/21603240-small-satellites-taking-advantage-smartphones-and-other-consumer-technologies.

synthetic aperture radar imaging.[19] Advancements in small satellite technology provide a robust assortment of mission options, yet a significant hurdle remains: getting to outer space.

Commercial and government organizations are pursuing independent small satellite launch vehicles expeditiously to meet growing demands. Today, a majority of small satellites are secondary payloads aboard large launch vehicles. Secondary payloads are susceptible to primary payload adjustments to the launch schedule inducing additional risks for the small satellite operator. Also, excess launch capacity is going unused in the United States. As a result, small satellite companies are shifting towards foreign launchers. Government agencies and commercial companies such as DARPA, Virgin Galactic, Boeing, Garvey Spacecraft, and Swiss Space Systems are investing in sub-orbital and air-launch concepts to meet this growing demand to launch small satellites. In the near future, it is reasonable to predict small satellite advancements and launch initiatives developing into an affordable and robust industry.[20]

The third contextual observation is the wide proliferation of counterspace weapons systems and commensurate strategies that decrease US warfighters' confidence in assured access to space capabilities. US space architectures fielded throughout the 1970s through 2000s condensed mission requirements into as few spacecraft as possible. In addition, the cost of fielding space capabilities was cut significantly by reducing the number of satellites required to launch. This optimization appeared reasonable because no substantial space constellation threats were recognized regarding the existence of weapons paired with likely hostilities. Disregarding the threat saved money. Assuming a benign space environment, however, is no longer realistic. In 2015, US satellites endured 261 reversible jamming events disrupting the information

19. Kiyonobu Ono, Takashi Fujimura, Toshiaki Ogawa, and Tsunekazu Kimura, "Small Sar Satellite Using Small Standard Bus," Proceedings of the AIAA/USU Conference on Small Satellites, Technical Session I: Mission Payloads and their Applications, 2011, 4-5, http://digitalcommons.usu.edu/smallsat/2011/all2011/11/.

20. Tom Maultsby, Aaron Q. Rogers, Lt Col Jason B. Mello, "Small Payload Launch Opportunities and Challenges," Proceedings of the AIAA/USU Conference on Small Satellites, Technical Session I: All Systems Go!, 2015, 9, http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3168&context=smallsat.

flow between space and ground segments.[21] Vulnerable satellite links between spacecraft and users represent attractive and highly lucrative targets for adversaries to negate with counterspace strategies.

Since first going to space in 1958, the United States built a space architecture serving as a backbone for global force projection in an information age. For cost efficiency reasons, the United States consolidated satellite signals on a limited number of space vehicles. This cost saving decision created a vulnerability for the United States. Adversary strategists seeking to offset the dominant US military and economic power envision dealing a paralyzing blow to US space satellites blinding the nation to a valuable array of sensors and data routers.[22]

Counterspace strategies gained traction following Operation DESERT STORM; wherein the United States showcased its military dominance paired with a debut of vulnerable space systems.[23] In 1999, two senior Chinese People's Liberation Army (PLA) colonels published a book titled *Unrestricted Warfare* proposing a counter strategy to the United States. In the book, author Qiao Liang states, "The first rule of unrestricted warfare is that there are no rules, with nothing forbidden."[24] PLA analysts emphasize destroying, damaging, and interfering adversaries space capabilities to "blind and deafen the enemy."[25] The PLA is acquiring additional space and counterspace capabilities including directed energy weapons and satellite jammers in addition to their demonstrated direct ascent kinetic kill capacity.[26] Developments from unrestricted warfare ideas materialized into a plethora of counterspace capabilities bolstering Anti-Access/Anti-Denial (A2AD) strategies. The potential pursuit of unrestricted warfare with A2AD strategies invalidates any idea of outer space being preserved as a sanctuary as events escalate towards open

21. Sydney J. Freedberg Jr., "US Jammed Own Satellites 261 times; What If Enemy Did?," Breaking Defense, 2 December 2015, http://breakingdefense.com/2015/12/us-jammed-own-satellites-261-times-in-2015-what-if-an-enemy-tried/.
22. Sam J. Tangredi, *Anti-Access Warfare: Countering A2/AD Strategies* (Annapolis, MD: Naval Institute Press, 2013), 243-245.
23. Qiao Liang and Xiangsui Wang. *Unrestricted Warfare*. (Beijing: PLA Literature and Arts Publishing House, February 1999).
24. Ibid., 2.
25. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014,* 32.
26. Ibid., 32.

warfare. US warfighters must not only accept that space warfare is a new reality, but they must be ready to fight to preserve the space-derived services upon which modern military operations depend while denying similar advantages to adversaries.

The fourth contextual observation compounding the complexity of the challenges facing military strategists is that the fabric of modern societies rely on a variety of military-provided services from space, just as modern militaries also rely on commercial satellite services. The military, civil, and commercial space architectures are fused. One example is the Global Positioning System, or GPS, which provides positioning, timing, and navigation data to the US and allied militaries and civilians around the world—free of charge. One economic study estimated the direct economic benefits derived from GPS technologies are over $67.6 billion per year in the United States with more than 3.3 million jobs reliant on this constellation's effects.[27] While modern society leverages military-provided satellite services, the military leans on commercial satellite providers. The US military's insatiable bandwidth demands developed following the terrorist attacks on September 11, 2001. By 2011, the Department of Defense reported expenditures exceeding one billion dollars leasing services from commercial satellite providers, many of them from companies based outside the United States.[28] Globalization permeates into and through contracted space services blurring the distinction between military and non-military assets.

Space systems assist or enable modern society's daily functions. A day without expected space-derived services would see outages across the internet, "cell phone networks, television, radio, ATM access, credit cards, and possibly even your electricity."[29] Modern society's entanglement with outer space is

27. Nam D. Pham, Ph.D., "The Economic Benefits of Commercial GPS Use in the U.S. and The Costs of Potential Disruption," June 2011, 1, http://saveourgps.org/pdf/GPS-Report-June-22-2011.pdf.
28. United States Government Accountability Office, Report to the Committee on Armed Services, U.S. Senate: DEFENSE SATELLITE COMMUNICATIONS DOD Needs Additional Information to Improve Procurements (Washington, DC: General Accounting Office, July 2015), http://www.gao.gov/assets/680/671484.pdf.
29. Minutes of "A Day Without Space: Economic and National Security Ramifications with Ed Morris, Steven Anderson, Ronald Hatch, Dr. Peter Hays, Maj. Gen. James Armor (ret.), and Dr. John Sheldon" Conference conducted at United States Chamber of Commerce, Washington, DC, 16 October 2008, 3, http://marshall.org/wp-content/uploads/2013/08/Day-without-Space-Oct-16-2008.pdf.

ubiquitous. Military violence employed against space architectures could affect the very fabric of modern society.

In sum, there are four developing contextual observations opening an avenue for an unorthodox approach to space strategy. First, congested orbits increase the risks of generating orbital debris. Failure to restrain space attacks could have catastrophic damage and produce a significant political backlash. Second, an emerging small satellite industry developments suggest a dramatic increase in the satellite population size in the coming years. Opportunities to leverage growing satellite numbers by "hiding" covert and hosted payloads amongst the masses rise if this technology continues developing. Third, proliferating counterspace weapons and doctrine indicates the real possibility of space warfare. No longer, can space actors ignore these developments and the United States should have a viable strategy to defeat space attacks if the day comes. Fourth, modern societies' reliance on space systems further compounds the complexity of space warfare. Nations' reliance on military and non-military space assets provides a backdrop for the formulation of any space strategy.

Strategy is the "art of creating power."[30] Strategy constantly adjusts to current realities generating advantageous options.[31] Thus, it makes sense to scan the past, present, and possible future to formulate viable conditions. This thesis analyzes space history, developing trends, and irregular warfare thought to create a new lens of space theory. An irregular space warfare lens enables a strategist to think about war from the high ground down.

30. Lawrence Freedman, *Strategy: a History* (New York, NY: Oxford University Press, 2013), 607.
31. Everett Dolman, *Pure Strategy: Power and Principle in the Space and Information Age* (New York, NY: Routledge, 2004), 6.

Chapter 1
Extension of politics in space

Centuries of warfare taught leaders that politics matter. Before 1942, space represented a world untouched by human endeavors.[1] Nearly 75 years later, humankind transformed space into a congested, competitive, and contested environment. How did a realm previously unscathed by humans or machines evolve? At the foundation of this evolution lies politics. Actions in space are merely reflections of earthly politics inextricably linked to diplomatic, informational, military, and economic interests.

This chapter argues that politics shape the space domain. It assumes nations' space policies or lack thereof influenced humankind's endeavors in the extraterrestrial environment. Political objectives adjust over time based on context; yet, a historical examination of US space policy reveals three common themes. First, the United States prioritized the ability to retain freedom of action in space throughout all presidential administrations. Second, presidential administrations pursued cooperation opportunities with other space actors when the conditions presented themselves. Third, US security concerns led to the exploration of options to control space over an adversary, when required.

US Evolution of Space Policy: Freedom of Action

The United States first enduring political aim in space is maintaining freedom of action. The roots of this goal originates from World War II (WWII). US entry into WWII solidified after the Japanese surprise attack on Pearl Harbor. Americans pursued an unconditional surrender relentlessly from both Nazi Germany and Imperial Japan during the war. WWII's finale unleashed nuclear destruction and started a new era based on threats of nuclear

1. Walter Dornberger, *V-2*, trans. James Cleugh and Geoffrey Halliday (New York, NY: The Viking Press, 1954), 17. The V-2 rocket marked the first time human technology invaded space. The former Commanding Officer of the Peenemunde Rocket Research Institute, Nazi German Major General Dornberger, stated, "This third day of October, 1942, is the first of a new era in transportation, that of space travel…"

armageddon: the Cold War. The Cold War resulted from the rise of two superpowers, United States and Soviet Union. The ideologically opposed powerhouses initially molded the creation of humankind's first space endeavors. US space policy revolved around shaping a space environment based on freedom of action.

Peering behind the Soviet's "Iron Curtain" was a primary security concern for the United States at the onset of the Cold War.[2] Inaccurate US predictions about the progress of Soviet nuclear weapons developments fueled US fear of another "Pearl Harbor."[3] The potential threat of a Soviet nuclear surprise attack served as a springboard for the United States to collect accurate information on the closed Soviet state. The United States decided to leverage the high vantage point of space to spy on the communist superpower.

Before Sputnik, the United States recognized the potential of enhancing strategic awareness from space. In 1945, Project RAND formed as a government initiative to tap into the US scientific and industrial expertise. The first RAND report released in 1946 introduced the feasibility of military space missions for the near future such as reconnaissance, communications, weather reconnaissance, and attack assessment.[4]

In 1954, President Eisenhower commissioned the Technological Capabilities Panel to explore potential reconnaissance options.[5] The top secret Technological Capabilities Panel report recommended prioritizing the U-2 spy plane and then a small satellite.[6] The report argued that a small scientific satellite could "explore or establish the principle that space, outside our atmosphere, is open to all."[7] A small scientific satellite launched in the International Geophysical Year between 1957 and 1958 would test political ramifications of a satellite's overflight of national borders. If an International

2. Peter L. Hays, *Space and Security* (Santa Barbara, CA: ABC-CLIO, 2011), 2.
3. Ibid., 2.
4. L. Ridenour et al., *Preliminary Design of an Experimental World-Circling Spaceship*, (Santa Monica, CA: RAND Corporation, 1946, 9-15. http://www.rand.org/pubs/special_memoranda/SM11827.html.
5. Dino A. Brugioni, *Eyes in the Sky: Eisenhower, the CIA and Cold War Aerial Espionage* (Annapolis, MD: Naval Institute Press, 2010), 92-93.
6. Hays, *Space and Security*, 4.
7. Technological Capabilities Panel of the Science Advisory Committee. 1955. *Meeting the Threat of Surprise Attack, Vol. II* (Washington, D.C, February 14); cited in Hays, *Space and Security*, 4.

Geophysical Year satellite could overfly countries without political implications, then the United States could use a covert military reconnaissance satellite to collect strategic intelligence. Therefore, the Eisenhower administration authorized a parallel military secret spy satellite program named Weapons System (WS)-117L. This covert satellite program would develop reconnaissance and surveillance satellites over 30 years ranging from recoverable film systems, electro-optical systems, infrared surveillance, and nuclear detonations capabilities.[8] By 1955, President Eisenhower approved the first national space policy, National Security Council 5520, exploring the freedom for countries to use space, the US scientific International Geophysical Year satellite proposal, and a covert WS-117L military program.[9]

Sputnik established the freedom of overflight in space and ignited US fears. In October 1957, the Soviet Union successfully launched Sputnik I and became the first space-faring nation.[10] Sputnik's continuous orbits did not generate international protest and thus "with the lack of worldwide objection to overflight, Sputnik I literally wrote overflight rights into international law."[11] One month later, the Soviets launched Sputnik II containing a passenger dog named Laika. American fears of technological inferiority surfaced.[12] Sputnik I and II validated the Soviet's long-range missile development and threatened America's extended deterrence credibility for its NATO allies.[13] While President Eisenhower never prioritized being the first nation to launch into space, domestic shock prompted a response.[14] Following Senate hearings, majority

8. Hays, *Space and Security*, 5.
9. Executive Office of the President, *NSC 5520* (Washington, DC: Executive Secretary, 11 October 1957), 2, 6, http://marshall.wpengine.com/wp-content/uploads/2013/09/NSC-5520-Statement-of-Policy-on-U.S.-Scientific-Satellite-Program-20-May-1955.pdf.
10. Asif A. Siddiqi, *Sputnik and the Soviet Space Challenge*, (Gainesville, FL: University Press of Florida, 2003), 166-168.
11. George M. Moore, Vic Budura and Joan Johnson-Freese, "Joint space doctrine: catapulting into the future," *Joint Forces Quarterly* (Summer 1994), 74.
12. Gene Kranz, *Failure is Not an Option: Mission Control from Mercury to Apollo 13 and Beyond* (New York, Berkley Books, 2001), 15.
13. Saki Dockrill, *Eisenhower's New Look National Security Policy, 1953-61* (London, Macmillan Press, 1996), 216.
14. Walter A. McDougall, *Heavens and the earth: a political history of the space age (*Baltimore, MD: Johns Hopkins University Press, 1985), 132-134.

leader Lyndon Johnson concluded, "We are in a race for survival and we intend to win that race."[15]

Ultimately, the perceived missile gap between the superpowers ignited after Sputnik. A top-secret review committee produced the Gaither Report painting a humbling picture of the US grave vulnerabilities from a Soviet surprise attack.[16] The report's conclusions, however, were based on the committee members' preconceived notions of Soviet intentions and inadequate intelligence estimates using limited U-2 photographs.[17] In 1958, President Eisenhower authorized the joint Air Force and CIA team control over one of the WS-117L programs named Corona.[18] The Corona program encompassed reconnaissance satellites using recoverable film.[19] By 1960, Corona produced data dispelling the missile gap notion. National intelligence estimates in 1957 predicted 500 Soviet ICBMs for 1961; however, satellite data altered estimates in 1961 to less than 10 operational ICBMs.[20] Overhead reconnaissance opened the Iron Curtain enabling national intelligence estimates based on photographic evidence and highlighted the importance of the new domain.

President Eisenhower's foresight to explore the notion of "freedom of action" in space and to prioritize strategic reconnaissance paid dividends to the United States. The right for nations to explore space originates from the precedence Sputnik established and the US reaction. The United States did not respond negatively to Sputnik because of the Eisenhower administration's desire to create conditions in space for satellite reconnaissance. Establishing conditions for gathering strategic intelligence from space would allow the United States to understand the Soviet nuclear missile threat better. An international

15. R. A. Divine, *The Sputnik Challenge (*New York, NY: Oxford University Press, 1993), 79.
16. Executive Office of the President, *Deterrence & Survival in the Nuclear Age* (Washington, DC: Security Resources Panel of the Scientific Advisory Committee, 7 November 1957), 14, http://nsarchive.gwu.edu/NSAEBB/NSAEBB139/nitze02.pdf.
17. David Lindsey Snead, "Eisenhower and the Gaither Report: The Influence of a Committee of Experts on National Security Policy in the Late 1950s" (PhD diss., University of Virginia, January 1997), 199-201.
18. Dino A. Brugioni, *Eyes in the Sky: Eisenhower, the CIA and Cold War Aerial Espionage* (Annapolis, MD: Naval Institute Press, 2010), 201.
19. Brugioni, *Eyes in the Sky: Eisenhower, the CIA and Cold War Aerial Espionage*, 200-202.
20. Hays, *Space and Security*, 12.

norm for all nations' right for freedom of action in space was the aim and established under President Eisenhower's watch. Freedom of action in space is an enduring US policy aim from its inception to today.

US Evolution of Space Policy: Cooperation

The second US enduring political objective in space seeks ways to cooperate with other actors. Reasons for nations to cooperate vary based on contextual circumstances. The US reason for solidifying cooperation as an enduring political aim originates from the quest for prestige. The Space Race to the Moon and detonating nuclear weapons in outer space signified a superpower prestige competition, yet concluded with lasting sparks of cooperation.

President Kennedy's inaugural address in January 1961 called for cooperation between the two superpowers, but a mere four months later commenced a competition for prestige: the Space Race to the Moon. As the world population surpassed three billion, the international audience saw the botched Bay of the Pigs invasion in April 1961. The following month, Kennedy addressed Congress calling for a commitment to landing a man on the moon, for "it will not be one man going to the moon…it will be an entire nation."[21] At the time, the Soviet's continually accomplished first of a kind space feats.[22] Kennedy was changing the race from a sprint to a marathon.[23] Strategically, Kennedy altered the structure of garnering prestige in the US favor. This policy's continuity spanned three presidents and offered an offset to the American Vietnam experience culminating in the American Apollo 11 moon-landing mission in 1969.

The Space Race to the Moon paved a way for the United States to accumulate prestige through competition and nuclear space tests offered posturing options to demonstrate technological superiority. In 1961, the Soviet Union conducted two high altitude nuclear explosions with one detonating in

21. President John F. Kennedy, "Special message to the Congress on urgent national needs" (address to Congress, Washington, DC, 25 May 1961), 9, http://www.jfklibrary.org/Asset-Viewer/Archives/JFKPOF-034-030.aspx.
22. Michael Sheehan, *The International Politics of Space* (New York, NY: Routledge, 2007), 30.
23. Sheehan, *The International Politics of Space*, 47.

low earth orbit at 184 miles.[24] By 1962, the U.S. tested multiple high altitude nuclear explosions culminating in the largest nuclear explosion in outer space, Starfish Prime, detonating at 249 miles above the earth.[25] Starfish Prime generated Electromagnetic Pulse effects impacting cities 898 miles away from the detonation.[26] Additionally, artificial radiation belts formed with "high electron fluxes and long lifetimes" affecting three on-orbit satellites indicated grave outcomes for massive military operations in the upper atmosphere.[27]

While Kennedy desired to frame the nuclear space tests as a response to the Soviet tests, an opportunity to find common ground and establish space laws emerged.[28] In October 1962, President Kennedy and Premier Khrushchev figured out a way to deescalate the 13-day Cuban Missile Crisis. The crisis validated that both superpowers could rationally reason through deathly tension. Building upon the terrestrial success, the leaders looked towards the stars. Environmental hazards of high altitude nuclear explosions coupled with the validation of the superpowers rational reasoning led to the Limited Test Ban Treaty in 1963.[29] This treaty banned high-altitude nuclear detonations.[30] By 1967, the United Nation's Outer Space Treaty continued the momentum

---

24. United States Central Intelligence Agency, *The Soviet Atomic Energy Program*, National Intelligence Estimate Number 11-2A-62 (Washington, DC: Director of Central Intelligence, 16 May 1962), 12, http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000843187.pdf.
25. Defense Atomic Support Agency, *Project Officer's Interim Report: STARFISH Prime*, Report ADA955694 (Albuquerque, NM, August 1962), 2.
Sandia National Laboratories, *Did High-Altitude EMP Cause the Hawaiian Streetlight Incident?*, System Design and Assessment Note 31 (Albuquerque, NM: Electromagnetic Applications Division, June 1989), 4, http://ece-research.unm.edu/summa//notes/SDAN/0031.pdf.
26. Sandia National Laboratories, *Did High-Altitude EMP Cause the Hawaiian Streetlight Incident?*, 3-4.
27. Herman Hoerlin, *United States High-Altitude Test Experiences: A Review Emphasizing the Impact on the Environment,* US Energy Research and Development Administration Report LA-6405 (Los Alamos, NM: Los Alamos Scientific Laboratory, October 1976), 1-2, http://www.fas.org/sgp/othergov/doe/lanl/docs1/00322994.pdf.
28. McGeorge Bundy, National Security Action Memorandum-183, "Space Program for the United States," 27 Aug. 1962, http://marshall.wpengine.com/wp-content/uploads/2013/09/NSAM-183-Space-Program-for-the-United-States-27-Aug-1962.pdf.
29. Sheehan, *The International Politics of Space*, 63.
30. Limited Test Ban Treaty of 1963, "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water," Bureau of Arms Control, Verification, and Compliance, 5 August 1963, http://www.state.gov/t/isn/4797.htm.

establishing an international space law-prohibiting orbiting weapons of mass destruction in outer space, rejecting national claims of sovereignty in outer space, and asserting the right for all nations to explore the domain.[31] These treaties presented enduring rules in space and demonstrated America's willingness to cooperate on addressing transnational problems.

Cooperation in certain space activities is a consistent American theme. Under the Eisenhower administration, US policy saw some cases where international cooperation in space was highly desirable and could enhance US advocacy using outer space for peaceful purposes.[32] The Kennedy administration maintained the cooperation theme with the Soviets early and near the end of President Kennedy's term. President Kennedy's direct responses to Chairman Khrushchev early in his term stated a desire to explore space together. Near the end of Kennedy's leadership, he proposed an unanswered option to explore the Moon jointly.[33] The Johnson administration continued cooperation options with the Soviets and the Europeans. NASA and Soviet Academy exchanges and development support to European Launcher Development Organisation (ELDO) represented two space activities emphasizing US cooperation with other nations.[34] The Nixon administration preserved open door communication with the Soviets, announced a willingness to exchange

---

31. UN General Assembly, Resolution 2222 (XXI), "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," 19 December 1966, http://disarmament.un.org/treaties/t/outer_space/text.
32. National Security Council Planning Board, National Security Council 5814/1, "Preliminary U.S. Policy on Outer Space," Dwight D. Eisenhower Presidential Library and Museum, 20 June 1958, 21-22, http://marshall.wpengine.com/wp-content/uploads/2013/09/NSC-5814-Preliminary-U.S.-Policy-on-Outer-Space-18-Aug-1958.pdf.
33. McGeorge Bundy, National Security Action Memorandum-129, "U.S.-U.S.S.R. Cooperation in the Exploration of Space," 23 February 1962, http://marshall.wpengine.com/wp-content/uploads/2013/09/NSAM-129-U.S.-U.S.S.R.-Cooperation-in-the-Exploration-of-Space-23-Feb-1962-.pdf.
President John F. Kennedy, National Security Action Memorandum-271, "Cooperation with the USSR on Outer Space Matters," 12 Nov 63, http://www.jfklibrary.org/Asset-Viewer/qVncp893wEmJFplIn1AlHA.aspx.
34. President Lyndon B. Johnson, National Security Action Memorandum-285, "Cooperation with the USSR on Outer Space Matters," 3 March 1964, http://www.lbjlib.utexas.edu/johnson/archives.hom/NSAMs/nsam285.asp.
President Lyndon B. Johnson, National Security Action Memorandum-384, "U.S. Cooperation with the European Launcher Development Organisation (ELDO)," 29 July 1966, http://www.lbjlib.utexas.edu/johnson/archives.hom/NSAMs/nsam354.asp.

technical data following the post-Apollo program, and provided launch assistance to the international community.[35] The cooperation theme continues through current times, but the amount of collaboration varies based on political circumstances.

US Evolution of Space Policy: Control the Domain Over Adversaries

The third US enduring political aim in space is to control space over an adversary when required. Fear served as the impetus for seeking control of the space domain. The aim for control in space has a temporal aspect and does not imply a permanent occupation or domination. Control focuses on the ability to use space while denying an adversary the same. The duration of controlling the environment depends on the circumstances and political objectives. The quest for control, however, followed President Nixon's détente with the Soviets and Chinese. The Nixon administration manipulated the strategic political chessboard masterfully to position an honorable American withdrawal from the Vietnam War. Following the American redeployment, the international narrative fused with the fear of a communist domino theory.

The perceived Communist threat after the Vietnam experience invigorated a US national space aim to control the space domain. Between 1968 and 1971, Soviets tested nonnuclear co-orbital anti-satellite capabilities highlighting the growing importance and vulnerabilities of space systems.[36] In 1976, President Ford directed studies to reduce potential satellite degradation and enhance means to verify attacks in space.[37] Several National Security Council studies concluded continued satellite vulnerability, but the development of an anti-satellite means could serve as a "bargaining chip."[38] By

---

35. Henry A. Kissinger, National Security Action Memorandum-70, "International Space Cooperation: US-USSR Activities," 10 July 70, http://www.nixonlibrary.gov/virtuallibrary/documents/nsdm/nsdm_070.pdf.
Henry A. Kissinger, National Security Action Memorandum-72, "Exchange of Technical Data between the United States and the International Space Community," 17 July 70, http://www.nixonlibrary.gov/virtuallibrary/documents/nsdm/nsdm_072.pdf.
Henry A. Kissinger, National Security Action Memorandum-187, "International Space Cooperation – Technology and Launch Assistance," 30 Aug 72, http://www.nixonlibrary.gov/virtuallibrary/documents/nsdm/nsdm_187.pdf.
36. Hays, *Space and Security*, 30.
37. Brent Scowcroft, National Security Decision Memoranda-333, "Enhanced Survivability of Critical U.S. Military and Intelligence Space Systems," 7 July 1976, https://www.fordlibrarymuseum.gov/library/document/0310/nsdm333.pdf.
38. Hays, *Space and Security*, 30.

1977, the Ford administration directed non-nuclear anti-satellite acquisitions capable of electronic nullification and physical destruction to prevent an exclusive sanctuary in space for the Soviets.[39] During President Carter's duration, the United States continued anti-satellite development while partaking in failed space arms control negotiations. Finally, the Carter administration established a comprehensive national space policy maintaining the principle of freedom of action, a favorable international legal environment, and anti-satellite research as a hedge against a Soviet breakout.[40]

During the 1980s, the United States sought ultimate control of space through the Strategic Defense Initiative (SDI). The United States was not involved in any major intervention when President Reagan entered the Oval Office. The same can not be said around the world, however, as the Soviets invaded Afghanistan, Saddam Hussein seized power in Iraq and engaged in a war with Iran, and China's domestic demands increased as its population surpassed one billion. The US National Space Policy, updated in 1982, added the notion of force application under the military space program.[41] In 1983, the Reagan administration initiated the SDI program to develop an anti-ballistic missile defense system. SDI's goal was to provide a veil of protection around the United States and to establish an international environment without nuclear weapons.[42] Space-based programs including space-based inceptors

39. Brent Scowcroft, National Security Decision Memoranda-345, "U.S. Anti-Satellite Capabilities," 18 January 1977, http://marshall.wpengine.com/wp-content/uploads/2013/09/NSDM-345-U.S.-Anti-satellite-Capabilities-18-Jan-1977.pdf.
40. President Jimmy Carter, Presidential Review Memorandum/ NSC-23, "A Coherent U.S. Space Policy," 28 March 1977, http://marshall.wpengine.com/wp-content/uploads/2013/09/PRM-NSC-23-A-Coherent-Space-Policy-28-Mar-1977.pdf.
President Jimmy Carter, Presidential Directive/NSC-37, "National Space Policy," 11 May 1978, http://www.jimmycarterlibrary.gov/documents/pddirectives/pd37.pdf.
41 National Security Directive-42, *National Space Policy*, 4 July 1982, 6, https://reaganlibrary.archives.gov/archives/reference/Scanned%20NSDDS/NSDD42.pdf.
42. National Security Decision Directive-119, *Strategic Defense Initiative*, 16 May 1983, 1, https://reaganlibrary.archives.gov/archives/reference/Scanned%20NSDDS/NSDD119.pdf.
National Security Decision Directive-172, *Presenting the Strategic Defense Initiative*, 30 May 1985, 14, https://reaganlibrary.archives.gov/archives/reference/Scanned%20NSDDS/NSDD172.pdf.

and sensors formed a vital portion of the SDI's architecture. Some authors argued SDI contributed significantly to the Soviet Union's demise from threat alone.[43] SDI did not come to fruition, but provided glimpses into a melding of human imagination and a space domain ripe for exploitation.

The reasons for controlling space over an adversary became apparent during the 1991 Iraq War. Unimpeded access to space allowed the US coalition near real-time intelligence, accurate weather predictions, intra-theater and inter-theater communications, and navigation aids.[44] Space assets supported the coalition forces' lethal air-centric campaign. The change in warfare to an air-centric campaign represented an inflection point in history towards an emerging precision reconnaissance-strike complex.[45] The US experience in the Gulf War changed American military thought.[46] Space force enhancements supported US combined arms maneuver providing a rationale for preserving it for oneself and denying it to an adversary.

Following the Gulf War, US policy further emphasized the importance of control in space. In 1999, the Clinton administration declared "unimpeded access to and use of space is a vital national interest–essential for protecting U.S. national security."[47] This statement reflects the first time a US administration declared the control for unimpeded access to space was of vital importance to the country. In 2006, the Bush administration reinforced possessing the capabilities to protect US space interest and deny hostile adversaries the use of space capabilities.[48] Additionally, the Bush administration explicitly opposed restrictions prohibiting or limiting US access to or use of space.[49] By 2010, the Obama administration reduced the previous

---

43. Simon P. Worden and John E. Shaw, *Whither Space Power? Forging a Strategy for the New Century* (Maxwell AFB, AL: Air University Press, 2002), xvi.
44. Sheehan, *The International Politics of Space*, 98.
45. Keith L. Shimko, *The Iraq Wars and America's Military Revolution* (New York, NY: Cambridge University Press, 2012), 88-90.
46. Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton, NJ: Princeton University Press, 2006), 133.
47. Executive Office of the President, *A National Security Strategy for a New Century* (Washington, DC, The White House, December 1999), 12. http://clinton4.nara.gov/media/pdf/nssr-1299.pdf.
48. National Security Presidential Directive-49, *U.S. National Space Policy*, 31 August 2006, 1-2, http://fas.org/irp/offdocs/nspd/space.pdf.
49. Ibid., 2.

administration's arms control language by considering arms control restriction proposals that are equitable, verifiable, and enhance US and allied national security.[50] However, the Obama administration maintained the option to defeat an adversary's use of space capabilities through space control missions.[51]

Between Operation DESERT STORM and Operation ENDURING FREEDOM, the United States developed a highly integrated military force fully leveraging space operations. In 1991, seventy-two hour air tasking orders confined air planners to a set battle rhythm.[52] In 2001, aircraft took off without targets and received real-time dynamic taskings. The employed ratio of guided munitions shifted from predominantly unguided munitions to a guided munitions majority.[53] The integration of space capabilities throughout US military forces emphasized the importance of controlling the domain from a military perspective. As the Under Secretary of the Air Force declared in 2004, "Space systems are inextricably woven into the fabric of America's national security."[54]

The US aim to control space over an adversary when required originated from fear and endured from a reliance on space systems. Following Vietnam, the Ford administration pursued ASAT technologies as a bargaining chip to contest Soviet endeavors. By the Reagan administration, the desire to eliminate a nuclear threat pushed the United States towards a failed attempt at controlling space with sophisticated space weapons. Following the 1991 Iraq War, the recognition of the advantages a military force derives from the space domain altered the importance the United States placed on orbital architectures. Further, US space integration with military forces solidified the

---

50 Executive Office of the President, *National Space Policy of the United States of America* (Washington, DC: 28 June 2010), 7, https://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.
51 Ibid., 14.
52. Minutes of "A Day Without Space: Economic and National Security Ramifications with Ed Morris, Steven Anderson, Ronald Hatch, Dr. Peter Hays, Maj. Gen. James Armor (ret.), and Dr. John Sheldon" Conference conducted at United States Chamber of Commerce, Washington, DC, 16 October 2008, 26, http://marshall.org/wp-content/uploads/2013/08/Day-without-Space-Oct-16-2008.pdf.
53. Ibid., 26.
54. Honorable Peter B. Teets, Under Secretary of the Air Force, "National Security Space in the Twenty-First Century," *Air and Space Power Journal* (Summer, 2004), 1, www.airpower.maxwell.af.mil/airchronicles/apj/apj04/sum04/teets.html.

asymmetric advantages gained from space and the need to preserve it for oneself while denying an adversary's space capabilities.

The Challenge: Proliferating Counterspace Equipment and Changing International Norms

The challenge facing the United States in achieving its three enduring space political objectives is proliferating counterspace weapons and changing international norms. In an anarchic international system, states pursue actions for their own interest. "Principal powers will simply not allow a space hegemon to emerge, and lesser powers may concede hegemony but will continue to seek asymmetric counters."[55] Developing counterspace weapons and adjusting the international norms of a satellite's right of over flight represents two counters other countries are exploring.

The proliferation of counterspace weapons systems and commensurate strategies decrease US warfighters' confidence to control the domain. Counterspace strategies gained traction following Operation DESERT STORM; wherein the United States displayed its military dominance, paired with heavy reliance on vulnerable space systems.[56] In 1999, two senior Chinese People's Liberation Army (PLA) colonels published a book titled *Unrestricted Warfare* proposing a counter strategy to the United States. The author, Qiao Liang, was quoted stating, "The first rule of unrestricted warfare is that there are no rules, with nothing forbidden."[57] PLA analysts emphasize destroying, damaging, and interfering with adversaries space capabilities to "blind and deafen the enemy."[58] The PLA is acquiring additional space and counterspace capabilities including directed energy weapons, satellite jammers, in addition to their demonstrated direct ascent kinetic kill capacity.[59] US warfighters must not only accept that space warfare is a new reality, but they must be ready to fight

55. Lt Col Bruce M. DeBlois, "Space Sanctuary: A Viable National Strategy," *Airpower Journal* (Winter, 1998) http://www.airpower.maxwell.af.mil/airchronicles/apj/apj98/win98/deblois.html.
56. Qiao Liang and Xiangsui Wang. *Unrestricted Warfare*. (Beijing: PLA Literature and Arts Publishing House, February 1999).
57. Liang and Wang, *Unrestricted Warfare,* 2.
58. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014,* (Washington, DC: Office of the Secretary of Defense, 24 April 2014), 32.
59. Ibid., 32

to preserve the space-derived services upon which modern military operations depend while denying similar advantages to adversaries.

Certain actions in space are challenging the right of unimpeded overflight in space. US space architectures fielded throughout the 1970s through 2000s condensed mission requirements into as few spacecraft as possible. This optimization appeared reasonable because there was not a perception of substantial threats to space constellations. Assuming unimpeded access to space, however, is no longer realistic. In 2015, US satellites endured 261 reversible jamming events disrupting the information flow between space and ground segments.[60] Vulnerable satellite links between spacecraft and users represent attractive and highly lucrative targets for adversaries to negate with counterspace strategies.

Conclusion

Space once represented a domain devoid of politics, but humans transformed space into another environment linked to politics. Actions in space are merely reflections of earthly politics inextricably linked to diplomatic, informational, military, and economic interests. The United States pursued political objectives in space since the dawn of the satellite. The US enduring political aims in space, regardless of the presidential administration, focuses on maintaining US freedom of action, seeking ways to cooperate with other space actors, and controlling space when required. The challenge facing the United States in achieving its three objectives is proliferating counterspace weapons equipment and changing international norms.

To solve these challenges, the United States needs a coherent strategy capable of setting advantageous conditions to attain the US enduring political objectives. This can not be accomplished with a purely diplomatic solution. A comprehensive solution will include the military and the recognition of space warfare in a future conflict. What does space warfare look like in the future and is space warfare even a theoretically sound term? The following chapters

60. Sydney J. Freedberg Jr., "US Jammed Own Satellites 261 times; What If Enemy Did?," *Breaking Defense*, 2 December 2015, http://breakingdefense.com/2015/12/us-jammed-own-satellites-261-times-in-2015-what-if-an-enemy-tried/.

attempt to address those questions. The next chapter tackles the latter question and argues how actions in space can be violent.

Chapter 2
Violence in Space

The previous chapter explored how human endeavors in space are merely extensions of politics. This chapter argues actions in space can be violent. The term space warfare is meaningless if disconnected from politics and violence. According to Clausewitz, war is an extension of policy by other means.[1] The "other" in his statement is violence. Thus, war is a continuation of politics by violent means. Therefore, an understanding of war must clarify the meaning and application of violence. Modern warfare challenges the notion violence is purely limited to the death of humans. Within modern battlefields lurk unmanned machines on the ground, in the air, and above the atmosphere capable of accomplishing military objectives through violence. In today's battlespace, there are attack opportunities across a plethora of targets. The intent of this chapter is to highlight that violence is no longer limited to Earth. Actors in the international system can use violence in outer space as a tool to achieve political and military objectives.

Violence is a term that can invoke a passionate debate. Professor Thomas Rid provides a clear framework to understand the use of violence. He conceptualizes four methods of violence: force, energy, agent, and code.[2] Within this context, violence in outer space can occur in three of the methods.

Violence is not just the use of force. British theorist, Emile Simpson, compartmentalizes violence into two components: the use and interpretation of force.[3] There are three categories in how an audience interprets violence: physical, emotional, and symbolic.[4] In space, violence is less physical, less emotional, and less symbolic than in traditional media of warfare.

---

1. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 87.
2. Thomas Rid, *Cyber War Will Not Take Place* (New York, NY: Oxford University Press, 2013), 12-14.
3. Emile Simpson, *War from the Ground Up: Twenty-First-Century Combat as Politics* (New York, NY: Oxford University Press, 2013), 15.
4. Rid, *Cyber War Will Not Take Place*, 15-20.

This chapter presents a theoretical discussion on violence. The purpose is simple: in order for space warfare to exist, violence must extend into outer space. The chapter starts with a definition of violence and then, juxtaposes the methods and interpretations of violence in a traditional and space example. The result is violence is no longer constrained to Earth.

Violence intends to harm, disable, damage, or destroy an intended target. The target can be an animate or inanimate object. The interpretation of violence varies based on the intended target's audience. Thus, violence has two components: the use and interpretation of violence.

First Component: The Use of Violence

There are four methods to administer the use of violence. King's College London professor, Thomas Rid, categorizes the application of violence into force, energy, agent, or code.[5] He views the first three methods as conventional direct forms of violence, and code as an indirect form. The following analysis will describe the four methods to administer violence, and how it applies in outer space.

Force is the first delivery method of violence. It originates from the laws of physics. Force causes an object with mass to change its velocity or distorts stationary objects. "The magnitude of force can be calculated by multiplying the mass of the body by its acceleration, be it a fist, a stone, a pike, a bullet, a grenade, even a missile."[6] An example of violence through force is when a missile launches off an aircraft's rails and slams into an intended target.

Violence in space utilizes force as a method to achieve political and military objectives. Satellites and international space stations are targets on orbit possessing mass. Anti-satellite missiles and co-orbital rendezvous satellites use force to hold on-orbit targets at risk. The United States and China recently demonstrated how the destruction of satellites could occur through force. In 2007, China obliterated its own defunct weather satellite with an anti-satellite missile into thousands of pieces as a show of force on the international stage.[7] In 2008, the United States annihilated a hazardous

5. Rid, *Cyber War Will Not Take Place*, 12-13.
6. Ibid., 12.
7. Gen William L. Shelton, "Military Space: A Strategic Crossroad," *Air & Space Power Journal* (September-October 2013): 5-6,

deorbiting satellite with a modified Navy missile ensuring the US satellite did not spread toxic fuel across potentially vulnerable societies.[8]

Energy is the second medium to administer the use of violence.[9] Energy creates power derived from physical or chemical resources. "Fire, heat, and explosions are used as powerful and highly destructive media of violence.[10] Throughout time, warriors used energy to destroy armies and villages. Homer chronicles how the cunning Greeks burned down the city of Troy after deceiving their foes with the Trojan Horse.[11] Americans unleashed devastating incendiary bombs from B-29s across the wood structured Japanese cities in World War II.[12]

Violence in space through energy supports political and military objectives. Data links facilitate the transfer of information between satellites and users. The data transmitted across space is a vulnerable target for malicious intent. The energy form of violence provides a method to target data links. Satellite jamming uses radiation waves as a lesser form of violence against data links. Lasers and high-powered microwave radiation at high intensities could permanently impair satellite electronics or burn out solar arrays.[13] An actor using the energy mechanism for violence could scale the amount of damage to a target based on the desired objective. If an objective is seeking a temporary denial of information flow across data links, reversible satellite jamming proportionally satisfies that intent. A more permanent obstruction of an actor's information flow in space would leverage higher intensity directed energy attacks to destroy or degrade satellite and control stations. From a theoretical standpoint, space theorist Everett Dolman

---

http://www.airpower.maxwell.af.mil/digital/pdf/articles/2013-Sep-Oct/SLP-Shelton.pdf.

8. Marc Kaufman and Josh White, "Spy Satellite's Downing Shows a New U.S. Weapon Capability," *The Washington Post*, February 22, 2008, http://www.washingtonpost.com/wp-dyn/content/article/2008/02/21/AR2008022100641.html.

9. Rid*, Cyber War Will Not Take Place,* 12-13.

10. Ibid., 13.

11. Lawrence Freedman, *Strategy: a History* (New York, NY: Oxford University Press, 2013), 24-25.

12. Michael S. Sherry, *The Rise of American Air Power: The Creation of Armageddon* (New Haven, CT: Yale University Press, 1987), 306-316.

13. David Wright, Laura Grego, and Lisbeth Gronlund*, Physics of Space Security: A Reference Manual* (American Academy of Arts and Sciences, Cambridge MA, 2005), 131.

suggested there are extreme scenarios to deploy and utilize on-orbit lasers for controlling outer space from low earth orbit.[14]

The third form of violence is through agents.[15] Agents adversely affect a target's health in a variety of ways. Weaponized agents impair humans leading to injury or death.[16] Chemical and biological weapons are examples of weaponized agents. In the trenches of World War I to today's civil war in Syria, weaponized agents unleashed havoc on intended targets.[17] The agents affect people and other living creatures. Orbital architectures are impervious to this deadly mechanism because agents only attack living organisms. Agents are the one form of violence that do not apply in outer space.

The last medium of violence is through computer code.[18] "Computer code can only directly affect computer-controlled machines, not humans."[19] Using computer code for violence requires exploiting vulnerabilities in existing computer networks, software, and hardware to affect the intended target. As weapon systems' complexity increases and the reliance on coding rises, the opportunities for using weaponized code increases. Remotely piloted vehicles are potentially susceptible to weaponized code hijacking control of the vehicles and issuing unauthorized commands. During a Congressional testimony, University of Texas professor Todd Humphries stated his graduate student team spoofed a GPS-guided remotely piloted vehicle causing it to plummet toward the ground.[20]

Violence in space utilizes weaponized computer code as a method to achieve political and military objectives. Control stations issue commands to satellites. The nodes along the pathway from issuing a satellite command from

14. Everett Dolman (comments at the Gathering of Space Theorists Debate, School of Advanced Air and Space Studies, Maxwell AFB, AL, 11 March 2016).
15. Rid, *Cyber War Will Not Take Place,* 13.
16. Ibid., 13.
17. Ian Pannell, "Syria civilians still under chemical attack," *BBC News*, 10 September 2015, http://www.bbc.com/news/world-middle-east-34212324.
18. Rid, *Cyber War Will Not Take Place,* 13.
19. Ibid., 13.
20. House, *Professor Tom Humphreys, Statement on the Vulnerability of Civil Unmanned Aerial Vehicles and Other Systems to GPS Spoofing, Submitted to the Subcommittee on Oversight, Investigations, and Management of the House Committee on Homeland Security*, 112th Cong., 2nd sess., 18 July 2012, 4-5, https://homeland.house.gov/files/Testimony-Humphreys.pdf.

the control station, ground antennas, and satellite antennas all represent entry points for weaponized code. Once an actor's weaponized code infiltrates orbital architectures, unauthorized commands could lead to the destruction of an intended target. Between 2007 and 2008, malicious code penetrated two US satellites' command and control systems. US Congressional testimonies revealed the responsible party gained complete control of a National Aeronautics and Space Agency managed earth observation satellite but did not issue commands.[21] Such demonstrations, if executed successfully, could allow an attacker to degrade or destroy satellites; highlighting how weaponized code is the third form of violence in space.

The first component of violence is the actual use of force, energy, agents, and weaponized code. In war, the four methods of violence provide decision makers options for achieving political and military objectives. Leaders seeking to extend violence into space have three choices. Force, energy, and weaponized code are the three methods of violence available to use in space warfare.

Second Component: Interpretation of Violence

The interpretation of violence is the second component of the violence equation. In *War From the Ground Up*, Emile Simpson describes how the utility of organized violence as an instrument of policy is determined by the meaning an enemy prescribes to the use of force.[22] When a person communicates a message to a listener, there are two parts: the message and the interpretation. The same happens in war. Decision makers need to understand the methods of violence and the interpretation of violence.

Physical, emotional, and symbolic are the interpretation categories of violence. Traditional notions of violence key in on the physical nature of violence. Violence "confronts individuals with the fragility of their existence, with the proximity of death."[23] Violence is not only limited to humans and can include critical infrastructure, treasured monuments, unmanned aircraft, and

21. House, *2011 REPORT TO CONGRESS of the U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION*, 112th Cong., 1st sess., 9 November 2011, 215-216, http://origin.www.uscc.gov/sites/default/files/annual_reports/annual_report_full_11.pdf.
22. Simpson, *War from the Ground Up*, 15.
23. Rid, *Cyber War Will Not Take Place,* 17.

orbiting spacecraft. During the American Civil War, Sherman's March devastated the South's economic countryside leaving no doubt in the Southerners' minds the costs of violence.[24] In 2002, a manned Iraqi MiG destroyed an unmanned US drone after a short aerial dogfight relaying a message the Iraqis would attempt to defend their airspace as the United States prepared to invade Iraq.[25] While the interpretation of violence changes based on the proximity that one faces death, attacks against economic bases and military aircraft still require interpretation of the physical nature of the violence.

Violence against orbital architectures is less physical than against humans. There is a scale to the intensity of violence. On the high-end is violence against a person and on the low-end is attacks against machines. An adversary's anti-satellite missile destroying a satellite would indicate a clear escalation in violence based on contextual tensions. A blinding laser or radio frequency jamming attack on a satellite is less physical yet points to some level of tension between actors. Thus, the interpretation of violence in space warfare is less physical than say land warfare, which targets people and things closer to humans.

The emotional interpretation of violence is the second category. The bonds formed between social interactions create psychological links. Severing these links through malicious actions or the threat of violence creates an internal response in the human mind. The internal dialogue that an individual processes when a psychological link severs depends on the contextual value assigned to the connection, and every individual is different.[26] The horrors of the battlefield emotionally challenges soldiers as comrades fall.[27] As violence distances from people and things, the emotional impact of violence decreases.[28]

---

24. Russell F. Weigley, *The American Way of War: A History of United States Military Strategy and Policy* (Bloomington, IN: Indiana University Press, 1973), 148-152.
25. Brian Glyn Williams, *Predators: The CIA's Drone War on al Qaeda* (Washington, DC: Potomac Books, 2013), 41-42.
26. Robert Jervis, *Perception and Misperception in International Politics* (Princeton, NJ: Princeton University Press, 1976), 54-56.
27. E. B. Sledge, *With the Old Breed: At Peleliu and Okinawa* (New York, NY: Presidio Press, 2007), 140-141.
28. Malcolm Gladwell, *David and Goliath: Underdogs, Misfits, and the Art of Battling Giants,* (New York, NY: Little, Brown and Company, 2013) 131.

During the Blitz in World War II, Londoners exhibited how people emotionally disconnect from the death and destruction.[29]

Violence against orbital architectures is less emotional than against humans. As the Blitz demonstrated, people psychologically disconnect as the separation between the violence and audience increases. It does not seem too far of a stretch to say violence against satellites is less emotional because it is a machine and separated from the audience. This does not mean there could not be some emotional impact on an interpreter of space warfare. For instance, Stanford University director Neema Moraveji describes how as people become more reliant on satellite navigation technologies this could lead to the brain's under-development in self-reliant exploration.[30] If an adversary decided to destroy the GPS constellation, there could be some emotional impact as societies' dependency on this technology increases. An intended target's emotional response to violence in space, however, will be less than an attack against a comrade in arms.

The symbolic aspect of violence is the third category. The potential to destroy people and things has an inherent power. This power is derived from the symbolic nature of violence. Non-state actors such as Al Qaeda and Islamic State of Iraq and the Levant (ISIL) established a symbolic aura to the extremes of violence they are willing to use. Al Qaeda strives to represent an organization which can inflict massive suffering on the West after it turned passenger occupied airliners into missiles on September 11, 2001. ISIL's attempt to garner symbolic power through shock is one reason they disseminate videos of executions showing ruthless beheadings or immolating prisoners alive. There is a symbolic difference between murders by gunshot versus burning a person alive in a cage. Even the United States leverages the symbolic aspect of violence. US troops and military equipment stationed in Korea for over fifty years makes a statement about US resolve to support an ally, South Korea, and deter its potential adversary, North Korea.

---

29. Ibid., 128-133.
30. John Brandon, "Is Technology Making Us Less Human?" *Techradar*, 6 August 2013, http://www.techradar.com/us/news/world-of-tech/future-tech/is-technology-making-us-less-human--1171002/2.

Violence against orbital architectures is symbolic. Technology alters the instruments of violence.[31] When the Outer Space Treaty was signed in 1967, weapons of mass destruction seemed to be the only way to use violence against satellites. Technological growth in weaponry increased the power and range of counterspace weapons. Russian announcements of satellite communication jamming weapons and Chinese anti-satellite demonstrations advertise the sophistication of space weapons as a symbolic deterrent to space reliant countries.

The second component of violence is how the intended audience interprets the use of force. Physical, emotional, and symbolic aspects are the interpretation categories of violence. In war, decision makers and their strategists consider how these three elements factor into the intended target's audience. In space warfare, violence is less physical, less emotional, and less symbolic than traditional warfare.

Conclusion

In conclusion, violence is no longer limited to Earth. Actors in the international system use violence in outer space as a tool to achieve political and military objectives. Violence intends to harm, disable, damage, or destroy an intended target. There are two components to violence: the use and interpretation of violence. Force, energy, agents, and weaponized code are the methods of violence. The three categories an intended target audience interprets violence are physical, emotional, and symbolic. This chapter revealed how leaders can use force, energy, and weaponized code in space. Additionally, violence in space is less physical, less emotional, and less symbolic than in traditional domains. Strategists must harmonize the use of violence and its interpretation to achieve political and military objectives.

Chapter 1 argued how actions in space are merely extensions of politics. This chapter presented how those actions can be violent. Clausewitz introduced the timeless theory of war. Politics, violence, and chance are what constitutes war.[32] In his time, the stars were far removed from the battlefield. In today's context, however, outer space is part of the battlespace. Politics and

31. Rid, *Cyber War Will Not Take Place,* 19.
32. Clausewitz, *On War,* 89.

violence extend into space and provides the theoretical justification for the term space warfare as a subset of war. The next chapter explores irregular warfare for insights to apply in space warfare.

Chapter 3
Irregular Warfare Principles

The purpose of a satellite is to receive a command, process the instructions, perform the task, and transmit data to a user of that information. The daunting challenge of the satellite's mission is to execute that sequence in outer space. Many miles above the Earth's atmosphere, the satellite filters the signal noise to locate specific command signals. Then it must execute the requested task in an environment that is exceptionally challenging by its very nature. Finally, the satellite uses its limited power source to transmit data to the intended receiver. All along this process, vulnerable satellites can be overwhelmed by a variety of offensive space attacks.[1] By contemporary design and architecture, a satellite is the weaker contestant in a potential space conflict. If a nation plans to leverage satellites in war, it must acknowledge satellites' inherent disadvantages and look for strategies to overcome them. Irregular warfare theory may assist in formulating a solution. The basic attraction of irregular warfare is the methods employed could help a weaker belligerent not only survive, but dominate. Understanding the theoretical nature, characteristics, and means of irregular warfare will provide a space strategist with a framework to develop a coherent strategy.

The nature of war is a consistent factor throughout history. Prussian theorist, Carl von Clausewitz, provided a timeless explanation on the nature of war. He bounds war into a trinity connected through politics, violence, and

1. Air Force Doctrine Document 2-2.1, *Counterspace Operations*, 2 August 2004, 31, http://fas.org/irp/doddir/usaf/afdd2_2-1.pdf. Air Force Doctrine Document 2-2.1 describes the "Five D's" (Deception, Disruption, Denial, Degradation, and Destruction) are possible effects when targeting orbital architectures. "Deception employs manipulation, distortion, or falsification of information to induce adversaries to react in a manner contrary to their interests. Disruption is the temporary impairment of some or all of a space system's capability to produce effects, usually without physical damage. Denial is the temporary elimination of some or all of a space system's capability to produce effects, usually without physical damage. Degradation is the permanent impairment of some or all of a space system's capability to produce results, usually with physical damage. Destruction is the permanent elimination of all of a space system's capabilities to produce effects, usually with physical damage."

chance.[2] Within these poles, the nature of war seeks political objectives through limited and unlimited methods depending on the desire and intensity to attain the objective.[3] The nature of war is the same for conventional and irregular warfare: it is "politics by other means."[4]

The character of irregular warfare differs from conventional war. Belligerents do not always fight symmetrically. For instance, guerrilla warfare represents an asymmetric method that could help a weaker side survive. Prominent irregular warfare practitioner and theorist, Mao Zedong, explained the basic characteristic of irregular warfare: combatants utilize direct and indirect forces to disperse and concentrate simultaneously creating an identification problem for adversaries.[5]

Although means of war depend on the context, Yale professor Stathis Kalyvas and British officer Emile Simpson capture two key themes in irregular warfare. Kalyvas identifies ways to address the identification problem in irregular warfare as centering violence as a function of control.[6] Simpson illuminates the value and difficulties of coupling violence with a strategic narrative when engaged in an irregular battle.[7]

This chapter presents the theoretical nature, character, and means for irregular warfare given these themes. An underlying assertion is that a coherent space strategy will incorporate irregular warfare theory because of a satellite's inherent weakness. The chapter starts with Clausewitz's idea of the nature of war. Then, it uses Mao's description to clarify the characteristics of irregular warfare. Finally, the chapter leans on Kalyvas and Simpson to highlight the means of irregular warfare.

---

2. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 89.
3. Ibid., 69, 88, 606, 611, 613-614.
4. Ibid., 87.
5. Mao Tse-Tung, "On protracted warfare," *Selected Works of Mao Tse-Tung (Beijing: Foreign Language Press, 1967)*, 219-222, 247-249.
6. Stathis N. Kalyvas, *The Logic of Violence in Civil War* (New York, NY: Cambridge University Press, 2009), 12.
7. Emile Simpson, *War from the Ground Up: Twenty-First-Century Combat as Politics* (New York, NY: Oxford University Press, 2013), 203-206.

The Nature of Irregular Warfare: Politics by Other Means

Carl von Clausewitz, born 1780, served in the Prussian army and first saw combat at the age of twelve.[8] Early military service started his career on a string of combat experiences against the French, including the famous Napoleonic battles. Reflecting on the lessons learned throughout this transformational period of warfare, Clausewitz collected his thoughts to explain war in the unfinished masterwork, *On War*. His theory characterizes war as a trinity connecting politics, violence, and chance.

Policy establishes the objective of war.[9] The simplicity of the previous statement was derived from the philosophically demanding work of Clausewitz. His famous dictum, "war is politics by other means," is perhaps his best known.[10] Clausewitz reasoned to the above conclusion by first examining the abstract notion of war. In the abstract, war is an act of violence to compel our enemy to our will.[11] Taken to the logical limits, this absolute idea of war would witness armed nations using all their available resources against the opponent until one was no longer able to resist. In theory this is true; however, history demonstrated a spectrum of conflict from threats of war to wars of extermination.[12]

Clausewitz discovered variations in conflicts connected to the underlying causes of war. Political considerations and the depth of national interest in the end objective always modified oscillations in force applied during war.[13] Real

8. Peter Paret, "Clausewitz," in *Makers of Modern Strategy: from Machiavelli to the Nuclear Age,* ed. Peter Paret et al. (Princeton, NJ: Princeton University Press, 1986), 188.
9. Clausewitz, *On War*, 610.
10. Ibid., 87.
11. Ibid., 75.
12. Richard Holmes, ed., *The Oxford Companion to Military History* (New York, NY: Oxford University Press, 2001), 211, 744. The Cold War (United States versus Soviet Union: 1949-1989) and the Final Punic War (Rome versus Carthage: 146 BC) are two examples at the extremes on the spectrum of conflict. The Cold War illustrates a threat of war. The United States and Soviet Union stood on the brink of an ideological war that never resulted in direct open hostilities between the two nations. (211) The Final Punic War represents an example of a war of extermination. The Romans utterly razed Carthage "to the ground, sowed salt in the ruins, and sold the inhabitants into slavery." (744)
13. Julian S. Corbett, *Some Principles of Maritime Strategy* (Annapolis, MD: Naval Institute Press, 1988), 26.

war was merely international relations differing in the method employed to achieve the goal set by policy. Thus, "war is merely politics by other means."[14]

Clausewitz observed a contextual revolution in warfare thanks to Napoleon. Before the French Revolution, European monarchs employed military commanders preferring elaborate battlefield maneuvers rather than engaging in decisive battles. Napoleon altered this European contextual form of war from a limited, positional warfare concept to a whole of nation, annihilation engagement whose aim was to destroy the enemy's main force. While the character of war between these two paradigms differed, the nature of the war linked to a political object remained consistent.

If policy establishes the desired end state, it constrains war's violence from reaching the extreme. Absolute warfare represents the extreme of war; merely meaning violence for violence's sake. Real warfare is about not just violence for violence's sake, but for a political purpose. Thus, the first and most critical question a political and military leader must ask is: what is the desired goal, the end state, and the political objective? This basic issue allows a strategist to determine the nature of war and avoid mistaking it for something or seeking to make it something, that was never inherently possible. Clausewitz states, "This is the first and the most far-reaching of all strategical questions."[15]

The object of war and the motive for its intensity determines whether the nature of war is unlimited or limited. Clausewitz exposed the profound insight of war tied to the object and the sacrifices for this object in his final book. He saw unlimited war where the political object was so vital to both belligerents; they were willing to fight to their limits to secure the object.[16] The other type of war, limited, was where the object to one or both belligerents was not worth unlimited sacrifices.[17] Thus, Clausewitz provided strategists with the notion that war is an extension of policy and will be unlimited or limited.[18]

14. Clausewitz, *On War*, 87.
15. Ibid., 88-89.
16. Corbett, *Some Principles of Maritime Strategy*, 43.
17. Ibid., 43.
18. Clausewitz, *On War*, 69, 88, 606, 611, 613-614.

The political object of war is either positive or negative. A positive object aim is to obtain something from the enemy—meaning the main line of effort will be offensive.[19] A negative object seeks to prevent the enemy from obtaining some advantage over oneself—leading to the main effort being defensive.[20] While conceptually these lead one to compartmentalize positive as attack and negative as defense, the truth of war is they are mutually complementary.[21] For example, in the 1904 Russo-Japanese War, Japan's main object was to prevent Russia from absorbing Korea. To secure this negative object, the Japanese sought to capture Korea conducting an offensive war in practice.[22]

Friction separates "real war from war on paper."[23] Clausewitz saw friction as "the force that makes the apparently easy so difficult."[24] Friction and the fog of war in a conflict introduce uncertainty into the equation for a strategist. The unknown leads to chance, a component of Clausewitz's trinity. Chance can affect a belligerent's forces positively or negatively. Clausewitz's concept of the culminating point of victory provides an example of the interaction between offense, defense, and friction. He highlights that an army's attacking force weakens the longer it advances while the defensive force strengthens during the retreat by drawing closer to its line of supplies. At some point, the offense reaches a point where their remaining strength is only enough to maintain a defense, and any further advance turns the scale of power over to the adversary.[25] Friction convolutes the exact culminating point of victory measurement by introducing chance into the calculus resulting in increasing uncertainty. Chance, friction, positive and negative objects, and uncertainty intermingle when employing violence for political objectives.

In sum, Clausewitz establishes the notion that war is a continuation of politics in another form—violence. From this theory, he outlines the nature of war seeking a positive or negative political object achieved through limited or unlimited war. Wars vary according to the desired objective and the intensity to

19. Corbett, *Some Principles of Maritime Strategy*, 31.
20. Ibid., 32.
21. Ibid., 33.
22. Ibid., 34.
23. Clausewitz, *On War*, 119.
24. Ibid., 121.
25. Ibid., 528.

attain it. Finally, chance from friction and uncertainty separates war on paper from real war.

The Character of Irregular Warfare: Mobility and Identification

While the nature of war as described by Clausewitz has stood the test of time, the evolution of war's character mutated based on the contextual circumstances of the moment. During the Napoleonic era, the French engaged in conventional and irregular warfare simultaneously. Napoleon's conquests in Europe steamrolled adversaries opposing him on the battlefield with conventional forces. Even Napoleon's genius, however, could not eradicate the Spanish guerrilla forces converting the battlefield to a battlespace of a prolonged war. The nature of conventional and irregular warfare are identical: politics by limited or unlimited violence for a political object. The character of traditional and irregular warfare are different in the quest for control.

Mao Zedong remains one of the few men who served as both practitioner and theorist in irregular warfare. Mao faced multiple conventional warfare defeats and discovered the value in the ability to survive and fight another day. By 1935, this son of a farmer became the leader of the Communist Party following the grueling Long March.[26] July 7, 1937, marked the day Japan attacked a Chinese garrison starting the Sino-Japanese War. Divided between the Communist and Nationalist parties, China faced a powerful imperialist adversary. Mao devised an irregular warfare strategy, centered on a protracted war, creating a Chinese united front against the Japanese ultimately expelling the foreign power from the sovereign territory.[27]

Central to Mao's theory of irregular warfare was the three stages of protracted war. In stage one, the enemy was on the strategic offensive and the Chinese on the strategic defensive.[28] The Chinese would adopt a mobile warfare denying the Japanese a decisive victory and supplementing with calculated guerrilla attacks in the enemy's rear. Mao characterized the second stage as a strategic stalemate where the enemy reached its culminating point of attack and needed to shift to a positional warfare strategy to protect occupied

26. Lawrence Freedman, *Strategy: a History* (New York, NY: Oxford University Press, 2013), 183-184.
27. Freedman, *Strategy: a History* 184-185.
28. Tse-Tung, "On protracted warfare," *Selected Works of Mao Tse-Tung*, 212.

territories.[29] This stage represented the pivotal phase of the war. Guerrilla warfare broadens into widespread fighting inflicting pain amongst the Japanese unprotected lines of supply supplemented with mobile warfare maneuvers for a long, protracted struggle.[30] In the final stage, a strategic counter-offensive drives an enemy's strategic retreat.[31] The mobile warfare takes the initiative supplemented with positional and guerrilla warfare. In this third stage, the Chinese would drive the Japanese off the mainland.

The guerrilla forces represented the key to Mao's strategy. If Mao could mobilize the rural populous to join the united front in a just war, he could hold off the militarily superior Japanese forces long enough to counter-attack. The ability to avoid a decisive battle and disrupt the Japanese supply lines introduced a massive amount of friction on the powerful military imperialist. Furthermore, it bought the Chinese additional time to continue advocating their just cause to their domestic audience and the international community securing foreign aid. Mao's strategic employment of attrition through a prolonged war coupled with annihilation engagements in tactical encounters founded his third warfare concept of the jigsaw.[32] He employed his guerrilla forces in attrition and annihilation maneuvers in an interlocking manner depending on the stages of the war. Guerrilla forces presented concentrated forces directly attacking Japan's undefended lines of supply and would disperse when faced with overwhelming force to avoid a confrontation.

In sum, Mao's protracted war against the Japanese highlights some unique characteristics of irregular warfare. Belligerents do not always fight on pre-determined battlefields to resolve wars. Guerrilla warfare represents a method that could help weaker sides survive. Strategically, guerrilla warfare is a defensive action leveraging public support and local knowledge to exhaust an adversary through tactically offensive tactics. Like a jigsaw's interacting pieces, guerrilla forces concentrate and disperse to attrite a foe through initiative, flexibility, and surprise. Combining indirect guerrilla forces with direct mobile

29. Ibid., 212-213.
30. Ibid., 212-213.
31. Ibid., 214.
32. Ibid., 219.

forces presents a militarily superior adversary with a complex dilemma to overpower.

The Means of Irregular Warfare: Control

Civil war represents an example of the complexity belligerents' face in irregular warfare. In *The Logic of Violence in Civil War*, Stathis Kalyvas defines a civil war as "armed combat within the boundaries of a recognized sovereign entity between parties subject to a common authority at the outset of the hostilities."[33] Kalyvas was struck by the seemingly enduring brutality of civil war, and set out to understand and explain violence that is committed intentionally against non-combatants in civil war.

In civil wars, violence is a function of control.[34] The established power and challenger jostle for control of the local populous. Typically, the challenger masks its identity from the incumbent through camouflage and concealment to distort the established power's ability to eliminate the rising threat directly. The local population collaborates with the power best able to ensure survival.[35] Belligerents seek information from the non-combatants to employ violence selectively, but this collaboration only occurs based on who controls the territory.[36] Depending on the amount of control determines the amount of cooperation. Thus, as control increases so does the collaboration from non-combatants.

Territorial regions fractured during internal conflicts directly influence the belligerents' application of violence. Kalyvas categorizes violence into indiscriminate and selective violence. Belligerents target non-combatants indiscriminately when it is difficult to determine who the adversary is in hopes of coercing areas to switch allegiances.[37] This form of violence carries adverse consequences to the enforcing power because it can create more adversaries inadvertently. Thus, depending on the amount of control a belligerent holds over a populous depends on whether they choose to target the locals indiscriminately.

33. Kalyvas, *The Logic of Violence in Civil War,* 5.
34. Ibid., 12.
35. Ibid., 12.
36. Ibid., 13.
37. Ibid., 171-172.

The selective violence method leads to direct application of force against an adversary and reduces unnecessary fratricide on non-combatants. Information is the key to focused, targeted violence. Belligerents' increased costs to attain the required situational awareness for selective violence is staggering.[38] Local collaboration represents an economical solution based on the asymmetric distribution of information. Locals provide the desired information belligerents seek regardless of pre-conflict loyalties only at the costs of establishing perceived conditions for their survival.[39] Therefore, selective violence is most likely to occur when locals supply enough information to meet the belligerents' intelligence demands.[40]

In sum, Kalyvas' logic of violence in civil war is an example of irregular warfare's complexity. Within this battlespace, identification of the adversary becomes a major challenge for those seeking to control a population through violence. Identification enables the distinction between selective and indiscriminate violence. Camouflage and concealment tactics mask belligerents' actions and the ability to selectively target actors, thereby increasing the costs of war to an adversary. Information from non-combatants enhances one's situational awareness by providing a solution for overcoming the identification problem but comes with the price tag of control.

The Means of Irregular Warfare: Strategic Narrative

Following three tours in Afghanistan, British infantry officer Emile Simpson honed in on the identification problem present in contemporary conflicts in *War From the Ground Up*. Simpson recognized the use of armed force was broadening from traditional Clausewitzian notions to establish military conditions for political solutions to the use of military force for direct political outcomes.[41] The idea of the "strategic corporal" creating effects on the battlefield with strategic implications exemplifies the tension between traditional and contemporary conflicts.[42] He compartmentalizes military force

38. Ibid., 139.
39. Ibid., 171.
40. Ibid., 13.
41. Simpson, *War from the Ground Up*, 4.
42. Major Lynda Liddy, "The Strategic Corporal: Some Requirements in Training and Education," *Australian Army Journal* 2, no. 2 (Autumn 2005): 139-140,

into two activities: the use of violence and the interpretation of the violence by an audience.[43] Force is a way to transmit meaning to be interpreted by a human agent.[44] The linkage between violence in battle and the interpretation of the violence as the language of war determines the purpose of war's outcome to drive a decision.

In irregular warfare, identifying an enemy and the broadening strategic audience compromises how belligerents interpret using armed force.[45] Traditional war theories assume there is a clear adversary. Sun Tzu linked victory in war explicitly to knowing the enemy while Clausewitz established the principle of polarity to make this distinction.[46] The principle of polarity assumed easily identifiable belligerents in combat engaged in offensive and defensive actions. This language of war asserts one's arguments while preventing the enemy's arguments to decide war's outcome.[47] For instance, guerrilla tactics allow a belligerent to hide and attack from amongst the civilian population tainting the concept of polarity. In irregular warfare, not all parties may know all the belligerents, and thus, the battlefield morphs into a battlespace where the incumbent searches for a belligerent to exert its military force.

The trouble identifying clear belligerents exaggerates as the strategic audience expands beyond the battlefield. If the belligerents do not know whom they are fighting, the interpretation of violence employed in war is compromised.[48] As we saw previously in the civil war example, violence employed indiscriminately impacts audiences beyond the combatants including non-combatants and the international community. Audiences interpret indiscriminate violence differently. If an incumbent bombs insurgents in a city indiscriminately, the insurgents may view the attacks as challenging their ability to exert influence and provide safety for the population, while the non-

---

http://www.army.gov.au/~/media/army/our%20future/publications/aaj/2000s/2005/aaj_2005_2.pdf.
43. Simpson, *War from the Ground Up*, 15.
44. Ibid., 27.
45. Ibid., 66-67.
46. Sun Tzu, *The Illustrated Art of War*, 205. Clausewitz, *On War*, 83.
47. Simpson, *War from the Ground Up*, 54-55.
48. Ibid., 67.

combatants who endure seemingly unprovoked violence may convert from non-combatant status to exact revenge against the incumbent. An interested international actor also may see the attacks as inhumane or threaten their interests and drive the country to intervene in the conflict. The numerous interpretations as the audiences expands dilutes the ability to use war to drive a direct political outcome. If multiple parties can claim victory legitimately then "war is largely a redundant political instrument to achieve a decision."[49]

Blurred polarity and expanded audiences in the irregular battlespace mandates the need to couple violence with a coherent strategic narrative. "Strategic narrative is the explanation of actions."[50] It explains actions: before, during, and after a conflict. The narrative tells a story appealing to logic, emotions, and morals.[51] Fragmented audiences complicate appealing purely to reasoning because violence in an irregular context is not interpreted according to traditional notions of war.[52] Individual interest amongst all the actors creates an environment more inclined to appeal to identity through emotions; defining victory across multiple audiences without a common interpretive structure, however, is generally impossible.[53]

A persuasive strategic narrative appealing to a diverse audience finds commonality in the moral component of human reasoning.[54] The moral component functions as the lowest common denominator. "Because history is not stable…strategy can use the flow of history as an emotional current upon which to float its rational narrative."[55] Appealing to the just cause of human decency through an emotional historical link provides a platform for a sound argument to use violence.

The final component of a compelling strategic narrative is the offering of a vision for the future. Providing an aspirational vision sets "conditions for future actions to be understood in a particular context which encourages people to see those actions in terms of what they were driving at, rather than in terms

49. Ibid., 67.
50. Ibid., 179.
51. Ibid., 225.
52. Ibid., 213.
53. Ibid., 207.
54. Ibid., 213.
55. Ibid., 216.

of the action itself."[56] Thus, a strategic narrative links the political context observed and desired from war with the violence employed by the armed combatants.

In sum, Simpson clarifies the use of violence into two categories: battles and the interpretation of the battle. In irregular warfare, the belligerents operate across a battlespace beyond the traditional battlefield. The expanded battlefield broadens the strategic audience interpreting the use of violence. Additionally, armed actors mask their identification when feasible convoluting the targeting process and increasing collateral damage risks. In this environment, coupling a coherent strategic narrative with the use of violence molds a stable interpretive structure for the fragmented political audience to move closer to a unified, perceived outcome.

Conclusion

Theoretically, irregular warfare revolves around the core problem of violence employed under the disguise of concealment. Clausewitz reveals actors' nature in war tends to employ violence in a limited versus absolute fashion because of fog, friction, and uncertainty. Mao unveils the character of irregular warfare's use of direct and indirect forces to concentrate and disperse simultaneously creating an identification problem for adversaries; thus, preventing the annihilation of the weaker belligerent. Kalyvas and Simpson drive home the means available to irregular warfare practitioners. Kalyvas addresses the core identification problem in irregular warfare by centering violence as a function of control. Simpson illuminates the value and difficulties of a strategic narrative when engaged in an irregular fight. The collective theorists above set a foundation for an irregular warfare strategist's orientation to the conflict. Due to satellites' inherent weakness, irregular warfare concepts of identification, use of guerrilla forces, and strategic communication emerge as unorthodox concepts to apply to the development of space strategy.

56. Ibid., 225.

Chapter 4
Guerrillas in Space

In war, there are times when the weaker belligerent attempts to create conditions conducive for overcoming a powerful adversary. Irregular warfare represents a method for such times. According to Sun Tzu, the pinnacle of strategy is to subdue an enemy without fighting by nullifying an adversary's strategy before the battle.[1] Unlike Sun Tzu's time, the battleground is no longer constrained to Earth. Far above terra firma, spacecraft attempt to distribute data across electromagnetic links while counterspace equipment seeks to prevent transmissions. A satellite is the weaker contestant in a potential space conflict. Irregular warfare concepts present a space strategist with survivable methods to overcome overwhelming counterspace environments.

The United States gains an asymmetric advantage over its foes by leveraging the space domain. Due to the vulnerability of satellites and the force multiplier effects that satellites provide the US military, multiple nations have developed formative counterspace capabilities.[2] The United States should adopt a defensive irregular warfare space strategy for three reasons. First, a defensive irregular warfare space strategy aligns with the limited nature of warfare in space. Second, this strategy creates an identification problem for a potential adversary by leveraging the guerrilla concept. Finally, there is an opportunity to shape the character of future conflict in outer space for the benefit of all space-faring nations.

---

1. Sun Tzu, *The Illustrated Art of War*, trans. Samuel B. Griffith (New York, NY: Oxford University Press, 2005), 115-117.
2. Both China and Russia are two examples of nations developing robust counterspace equipment.
Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014,* (Washington, DC: Office of the Secretary of Defense, 24 April 2014), 32.
"Invisible warfare: Russia touts second-to-none jamming equipment," *Sputnik News*, 7 March 2016, http://sputniknews.com/russia/20160307/1035897115/russia-electronic-warfare-systems.html.

The nature of warfare in space is "politics by other means."[3] British theorist, Sir Julian Corbett, enriches Clausewitz's "limited war" classification with the strategic isolation concept.[4] Applying the strategic isolation criteria to the space domain reveals that conflict in space tends to be more limited than unlimited because of its geographical separation from Earth and the variance actors place on the political importance of orbital architectures. The nature of space warfare is linked to politics and tends to be limited.

The character of irregular warfare differs from conventional warfare. An irregular warfare space strategy leverages a guerrilla concept as an asymmetric method to help military forces derive benefits from space signals in a contested environment. Combining indirect guerrilla space forces with existing US space assets presents a potential adversary with a complex targeting dilemma to overpower. The character of a defensive irregular warfare space strategy creates an identification problem for a potential adversary.

Although means of a defensive irregular warfare space strategy depend on the context, the former US Department of State strategist David Kilcullen's Competitive Control Theory serves as a useful framework to link desired objectives and actions. Kilcullen describes a predictive and functional normative system that offers incentives and disincentives as the key ingredients for control. Messaging bridges a normative system with the intended audience. Since space assets are inherently global, shaping a sustainable space environment requires a strategic narrative for the international audience. Future space energy endeavors present an opportunity to develop a compelling narrative for shaping responsible behavior in outer space based on actors' historical strategic restraint.

This chapter presents the theoretical nature, character, and means of irregular warfare in space. The chapter starts with a discussion about the nature of space warfare. Then, guerrilla warfare concepts applied in a space

3. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 87.
4. Julian S. Corbett, *Some Principles of Maritime Strategy* (Annapolis, MD: Naval Institute Press, 1988), 55.
Strategic isolation refers to a limited area separated "or to be capable of being reduced to practical isolation by strategical operations."

context describe the character of irregular space warfare. Finally, the chapter describes how the means of irregular space warfare start with shaping a new normative structure linked to a compelling strategic narrative.

Nature of Space Warfare: Limited

Clausewitz linked the nature of war to politics. This is true in irregular warfare and extends into the space domain. Belligerents seeking to use violence in space will do so for obtaining a political objective. Thus, any attacks in outer space should consider its relationship to politics and chance.

The idea of an absolute space attack divorced from politics and chance is inconceivable. Such an attack would exhibit belligerents using all their available resources against orbital architectures until the target constellations are no longer operational. An exo-atmospheric nuclear explosion, multiple kinetic anti-satellite missiles, or irreversible non-kinetic attacks represent some means to devastate satellites. Launching such an attack would have no logical limit if conducted in isolation, executed in a single decisive act, and resulted in a complete final decision.[5] An attack of this magnitude would be related to some previous political build-up, however, and would not be an isolated event. Since orbital architectures merely enhance national instruments of power, a nation without space assets would still possess all elements of national power to mount a response albeit at a reduced level. A belligerent seeking a decision through a single obliterating space assault would fail to eliminate the target's ability to respond even if the response is not instantaneous. The ideological extreme of an eradicating space attack originating out of the abyss unrelated to policy and chance is beyond feasibility.

Politics provides the reason for employing violence in outer space. The probability of violence extending into space will begin with the interaction between potential belligerents. The formation of strategy starts with an estimate of a potential adversary's relative power. The warring parties' character, leadership, territorial positioning, institutions, and weather

5. Clausewitz, *On War*, 77-89. Clausewitz explored the thesis of war as purely an act of force with no logical limit and concluded war is never taken in isolation or able to deliver a single decisive blow without some form of political escalation in tensions. Therefore, war is composed of violence, chance, and an instrument of policy.

considerations comprise the fundamental factors to generate an estimate.[6] Any estimate is based on the probability to achieve a particular objective. The objective originates from policy, "the original motive," and is foundational to strategy.[7] As the desirability of attaining an objective changes so does the application of violence. For instance, in 2003, an uplink ground based jammer from the Iranian embassy in Cuba denied US Voice of America broadcasts into Iran transmitting from the TelStar 12 communication satellite.[8] America's intent to broadcast news into the Middle East differed from the Iranian objective to limit western informational influence on its citizens. The clash of political aims can result in the use of violence in space.

There exists a spectrum of violence to serve belligerents' political and military objectives. The spectrum of violence in war ranges from the threat of force to the use of force. Prepositioning forces, show of force, non-kinetic operations, and kinetic operations represents some options available for decision-makers.

Prepositioning forces strategically places personnel, military equipment, and supplies in key areas to ensure rapid availability at the outbreak of war. The US Air Force maintains air bases around the world as a way to ensure the capacity to project airpower globally. In the space context, space architectures preposition on-orbit and include terrestrial assets. US Air Force's Geosynchronous Space Situational Awareness Program (GSSAP) represents a version of orbital prepositioned surveillance satellites near the geosynchronous belt to monitor peculiar space activities like Russian rendezvous and proximity operations.[9] Terrestrial defensive space control equipment positioned to detect,

6. Tzu, *The Illustrated Art of War*, 91.
7. Clausewitz, *On War*, 80.
8. "Satellite Jamming in Iran: A War Over Airwaves," *A Small Media Report*, November 2012, 17, http://www-tc.pbs.org/wgbh/pages/frontline/tehranbureau/SatelliteJammingInIranSmallMedia.pdf.
9. Mike Gruss, "U.S. Air Force Declares GSSAP Surveillance Sats Operational," *SpaceNews*, 8 October 2015, http://spacenews.com/u-s-air-force-declares-gssap-surveillance-sats-operational/.
Brian Weeden, "Dancing in the dark redux: Recent Russian rendezvous and proximity operations in space," *The Space Review,* 5 October 2015, 1-3, http://www.thespacereview.com/article/2839/1.

characterize, geolocate, and report radio frequency interference is another version of prepositioning space forces.[10]

Show of force with military power intends to warn a targeted audience or demonstrate one's capabilities. The US Air Force leverages show of force options to demonstrate a willingness to act if provoked. The B-52 low-level flight over South Korea early in 2016 was a signal to North Korea following their nuclear test.[11] The Soviet Union's series of co-orbital anti-satellite tests between 1968 and 1982 represents another show of force example targeted at the United States during the Cold War.[12]

Non-kinetic operations "produce effects without direct use of the force or energy of moving objects, including such means as electromagnetic radiation, directed energy, information operations, etc."[13] The "Berlin Airlift" represented the first air operation of the fledging US Air Force and was a monumental non-kinetic operation in defiance of Soviet hostilities that kept the Cold War cold.[14] In South America, criminal syndicates conducting unauthorized activities like deforestation hijacked US Navy satellite communications to provide illegal loggers warnings of approaching authorities.[15] The unauthorized loggers can use non-kinetic space operations as a way to avoid authorities to sell harvested products for profit.

Kinetic operations relate to "actions that involve the forces and energy of moving bodies including physical damage to or destruction of targets through

10. The 16th Space Control Squadron is an USAF unit responsible to employ defensive space control equipment to support theater campaigns. http://www.peterson.af.mil/library/factsheets/factsheet.asp?id=8403
11. Tony Munroe and Jack Kim, "U.S. flies B-52 over South Korea after North's nuclear test," *Reuters*, 10 January 2016, http://www.reuters.com/article/us-northkorea-nuclear-idUSKCN0UN0Y420160111.
12. Peter L. Hays, *Space and Security* (Santa Barbara, CA: ABC-CLIO, 2011), 30.
13. Air Force Doctrine Document 1-02, *Air Force Supplement to the Department of Defense Dictionary of Military and Associated Terms*, 11 January 2007 Incorporating Change 1, 6 January 2012, 48, https://fas.org/irp/doddir/usaf/afdd1-2.pdf.
14. Roger G. Miller, *To Save a City: The Berlin Airlift, 1948-1949* (2000; repr., College Station, TX: Texas A&M University Press, 2008), 34.
15. Marcelo Soares, "The Great Brazilian Sat-Hack Crackdown," *WIRED*, 20 April 2009, http://www.wired.com/2009/04/fleetcom/. Additionally, nation-state actors are not the only players in the international system. Non-state actors also use the spectrum of violence to achieve objectives. A plethora of options are available to actors as one rises in the spectrum of violence.

use of bombs, missiles, and similar projectiles."[16] US Air Force combat missions during Operation DESERT STORM represented the first time in history airpower was allowed to dominate a large-scale kinetic military campaign and "proved itself beyond expectations."[17] A unique aspect to the nearly sixty years of space history is there is no evidence of an actor conducting kinetic operations against another's on-orbit space assets.[18] The taboo of states not destroying another nation's satellite kinetically is a line not crossed yet.

The spectrum of violence exists in all domains as a means to achieve a political objective. The application of the violence spectrum connects to larger contextual factors. History fills library halls with documented examples of wars of extermination to mere threats of war. The intensity of war variations depends on the importance a belligerent places on the political objective.[19] Thus, "war is an act of policy."[20]

Even with clear aims, war is a subjective endeavor based on probabilities and not absolutes because of the danger associated with violence and imperfect information.[21] At the macro level, the defense possesses the advantage due to the strength garnered from interior lines, additional protection from fortifications, and potential increases in international support.[22] At the micro level, however, space attacks against on-orbit assets have the advantage because of satellites' limitations. Satellites' disadvantage in warfare occurs because of predictable orbits, extended satellite links, speed of light attacks, and limited propellant. Since any form of violence connects to the larger contextual factors, macro level factors still apply strategically; tactically space, however, is an offensive dominant domain. Space attacks do not occur in a vacuum, and a belligerent may desire to wait for a more advantageous situation in fear of retribution.

---

16. AFDD 1-02, *Air Force Supplement to the Department of Defense Dictionary of Military and Associated Terms*, 45-46.
17. John Andreas Olsen, ed., *A History of Air Warfare*, (Washington, DC: Potomac Books, 2010), 175.
18. John J. Klein, *Space Warfare: Strategy, Principles and Policy* (New York, NY: Routledge, 2006), 71.
19. Clausewitz, *On War*, 81.
20. Ibid., 87.
21. Ibid., 84-86.
22. Ibid., 470.

Additionally, imperfect situational awareness reduces the certainty to achieving an objective. Decision-makers' perceptions of a situation diverge from reality because of imprecise inferences to new incoming information.[23] Clausewitz warns imperfect knowledge can lead to ill-timed action and ill-timed inaction.[24] In one aspect, space assets reduce the uncertainty by providing commanders observational data from the high ground. In another aspect, the many vulnerabilities existing along this information pipeline presents belligerents entry points for non-kinetic deception and other negation techniques to manipulate a satellite's data. Gaps in space situational awareness expose decision-makers to significant amounts of uncertainty in determining whether to conduct space attacks.

The subjective nature of deciding to use violence in war mandates a leader to ask what is the desired end state. If the objective is unlimited, both actors are willing to go to the extremes of violence. In the purely space realm, it seems imprudent for the United States adopting an unlimited approach to space warfare because belligerents would end up destroying each other's orbital assets and result in a catastrophic amount of orbital debris. RAND analyst Forrest Morgan argues a "if you shoot ours, we'll shoot yours" model sounds reasonable; however, "given the disproportionate degree to which U.S. forces depend on space support as compared to potential adversaries, it would probably lack sufficient potency to deter a serious opponent."[25] If there is, any desire to garner benefits derived from outer space following war, then an unlimited war in space is impractical. The devastation possibility from an unlimited space warfare scenario in today's offensive-dominant context is imprudent.

Holistically, the United States could end up in an unlimited war and minimize attacks in space. The strategic importance of space to the United States is unquestionable. The National Space Policy of the United States explains, space systems "allow people and governments around the world to see

23. Robert Jervis, *Perception and Misperception in International Politics* (Princeton, NJ: Princeton University Press, 1976), 3.
24. Clausewitz, *On War*, 84.
25. Forrest E. Morgan, *Deterrence and First-Strike Stability in Space A Preliminary Assessment*, (Santa Monica, CA: RAND Corporation, 2010), 26.

with clarity, communicate with certainty, navigate with accuracy, and operate with assurance."[26] In an unlimited war, the United States could acquire means to contest an adversary's use of space assets temporarily while preserving for itself a minimum essential level of space enhancements and the space environment. Reversible non-kinetic attacks and covert satellites (explained later in this chapter) would provide an option to accomplish such objective.

While unlimited war is conceivable, the nature of space warfare will be limited predominantly. In limited war, one or both belligerents view the object not worth unlimited sacrifices.[27] Sir Julian Corbett proposed a limited object meets one of the two essential conditions: limited political importance and strategically isolated.[28] The political significance an actor places on space assets varies by a nation's reliance and investment in outer space. A common dominator exists, however, for all space-faring countries: satellites are not humans nor does the loss of orbital architectures represent an existential threat to any nation in and of themselves. Thus, the political importance of space architectures is relatively limited. Strategic isolation refers to a limited area separated "or to be capable of being reduced to practical isolation by strategical operations."[29] All on-orbit assets are strategically isolated from nations' homeland borders and further justify why the nature of space warfare will be limited.

The political object of space warfare is either positive or negative. A positive object seeks to obtain something from the enemy.[30] In *Space Warfare Strategy, Principles and Policy*, John J. Klein states the reason for seeking a positive object is "to obtain general or persistent command of space, thereby ensuring one's access and use of space."[31] A political negative object seeks to prevent the enemy from obtaining some advantage over oneself.[32] Using Klein's

---

26. Executive Office of the President, *National Space Policy of the United States of America* (Washington, DC: 28 June 2010), 1, https://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.
27. Julian S. Corbett, *Some Principles of Maritime Strategy* (Annapolis, MD: Naval Institute Press, 1988), 43.
28. Ibid., 55.
29. Ibid., 55.
30. Corbett, *Some Principles of Maritime Strategy*, 309.
31. Klein, *Space Warfare*, 71.
32. Corbett, *Some Principles of Maritime Strategy*, 33.

positive object rationale, one can construct the reason for finding a negative object. A negative object disputes or contests general or persistent command of space to prevent an adversary's access and use of space. The 2003 Iraq War provides a limited positive and negative object example from a space warfare perspective. During this war, the Iraqis attempted to prevent the United States from accessing the Global Positioning System (GPS) Precision, Navigation, and Timing (PNT) enhancements through the use of electronic jammers, the pursuit of a negative object. The United States destroyed the Iraqi's GPS jammers to secure the PNT effects from the space constellation, the pursuit of a positive object.[33]

In sum, the nature of space warfare links to politics. Space warfare is more limited than unlimited because of its geographical separation from Earth and the variance actors place on the political importance of orbital architectures. Political desirability for a positive or negative objective determines the amount of violence used. The spectrum of violence available for decision-makers to use in space ranges from the threat of force to the use of force. When a leader resorts to the actual use of force, reversible to non-reversible options are available in space. The probabilities of achieving the desired objective with space attacks lack clarity due to the danger of retaliation and imperfect information.

The Character of Guerrilla Space Warfare: Dispersal and Concentration

Historical developments in outer space confirm the nature of space warfare is limited. James Clay Moltz, *The Politics of Space Security*, masterfully walks through the first fifty years of space history revealing a domain uniquely exhibiting military restraint.[34] The Cold War superpowers restrained from developing space-to-Earth weapon systems. Additionally, the superpowers did not destroy each other's spacecraft and averted the generation of orbital debris.

---

33. Maj Keith W. Balts, "The Next Evolution for Theater Space Organizations: Specializing for Space Control," in *Space Power Integration Perspectives from Space Weapons Officers*, ed. Lt Col Kendall K. Brown (Maxwell AFB, AL: Air University Press, 2006), 120.
Teri Schultz and Wendell Goler, "Military Wipes Out Iraqi GPS Jammers," *Fox News*, 25 March 2003, http://www.foxnews.com/story/2003/03/25/military-wipes-out-iraqi-gps-jammers.html.

34. James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 2nd ed. (Stanford, CA: Stanford University Press, 2008) 332-333.

The superpowers' restraint fostered an environmentally stable domain. Moltz later contends that as additional space actors emerge, the stability of space security is at a crossroads. New and old actors can choose to reinforce or ignore military restraint at the peril of all nations.[35] For states concerned about maintaining military restraint and enhancing space security, understanding the character of an irregular warfare strategy in space will satisfy both criteria.

The characteristics of an irregular warfare strategy are to create an identification problem for a potential adversary through dispersing and concentrating direct and indirect forces. According to Mao, direct forces are more linked to conventional forces while guerrilla warfare is indicative of indirect forces.[36] An unconventional approach to space strategy leverages the guerrilla concept in two ways. First, a guerrilla space concept can provide terrestrial forces with a minimum essential level of enhancements from user equipment capable of exploiting foreign and commercial satellite signals. Second, deploying covert payloads on small satellites when one's main space systems face an overwhelming counterspace adversary is another form of a guerrilla space concept.

The United States is in a prime position to employ a space irregular warfare strategy. Strategically, a space irregular warfare strategy is defensive in nature. The strategy leverages the rules-based international order, the idea of a shared space common; and the United States' willingness to underwrite a free global utility. Tactically, space irregular warfare strategy creates a guerrilla capability to provide a survivable element to the United States' space portfolio.

At the strategic level, the US orbital architectures are robust and provide a general deterrent effect. In the RAND study, *Deterrence and First-Strike Stability in Space*, Forrest Morgan articulates some US orbital systems are sufficiently durable and present poor targets for prospective attackers.[37] Morgan describes how a deterrence strategy affects both sides of an adversary's cost-benefit equation. On the cost side, the United States declared in its

35. Ibid., 336-348.
36. Mao Tse-Tung, "On protracted warfare," *Selected Works of Mao Tse-Tung (Beijing: Foreign Language Press, 1967)*, 219-222.
37. Morgan, *Deterrence and First-Strike Stability in Space A Preliminary Assessment*, 19, 35.

National Space Policy to retaliate against attacks on its space systems.[38] Influencing the benefits side, Air Force Space Command is pursuing the concept of disaggregating space missions amongst more satellites to increase the resiliency of military constellations.[39] The US willingness to respond to space attacks and the general resiliency of its military constellations provide a general deterrent effect against a potential adversary.

A rules-based international order provides the United States the strategic justification to defend against satellite attacks. The inherent right of self-defense is a long-standing tradition for any nation and was founded in the United Nations.[40] An attack against nations' sovereign satellites provides the rationale for any nation to respond in a manner proportional to the assault. With the appropriate level of situational awareness, the United States can use the evidence of an adversary's space attack as a justification for retaliation.

Since humans started exploring outer space, the domain has been labeled a shared commons. Sputnik I established the principle of freedom of overflight for all orbital objects.[41] An actor resorting to aggressive actions in space is seeking to contest this established principle. Any space attack challenges sixty years of a shared commons precedent and provides the defending nation the moral authority to garner additional international support.

The willingness of the United States to underwrite a space global utility is an expression of America's cooperative character. The United States Air Force operates the GPS constellation providing the world with precise navigation and timing signals free of charge. The American taxpayers paid over $1 billion in fiscal year 2015 just to maintain and modernize this $3.6 billion constellation for domestic and international consumption.[42] GPS enables international

38. Executive Office of the President, *National Space Policy of the United States of America*, 3.
39. Air Force Space Command, *Resiliency and Disaggregated Space Architectures*, White Paper, 21 August 2013, http://www.afspc.af.mil/shared/media/document/AFD-130821-034.pdf.
40. UN General Assembly, "Charter of the United Nations and Statute of the International Court of Justice," 26 June 1945, Article 51, http://www.un.org/en/sections/un-charter/chapter-vii/.
41. Hays, *Space and Security*, 7-23.
42. National Coordination Office for Space-Based Positioning, Navigation, and Timing, "Fiscal Year 2015 Program Funding," GPS.gov, 30 December 2014, http://www.gps.gov/policy/funding/2015/.

governments and businesses around the globe to improve the efficiency of their operations. A space attack against GPS is not just an attack against the United States; it is an assault on a global utility that would reverberate throughout the world.

Thus, a US irregular warfare space strategy is strategically defensive because of the existing rules-based international order; the concept of a shared space commons; and the United States' willingness to underwrite a free global utility. Tactically, an irregular space warfare strategy creates a guerrilla capability to provide a survivable element to the United States' space assets. Since space is an offensive-dominant domain, the United States needs to develop and field guerrilla space capabilities for the United States to prevent the complete loss of its space enabling capabilities. A guerrilla capability denies an adversary the option of eliminating a US military retaliation without space enhancements. This would significantly raise the threshold of deciding to attack the "vulnerable" US orbital architectures.

Space guerrilla capabilities include comprehensive user equipment and covert payloads to provide terrestrial forces with a minimum essential level of space enabled force enhancements. Guerrilla forces can resist overwhelming odds because of flexibility and mobility.[43] Che Guevara's, *Guerrilla Warfare*, explains that full help from local populations is an indispensable condition for guerrilla fighters.[44] In space warfare, "guerrilla" user equipment should incorporate as much support as possible from all space-faring nations.

"Guerrilla" PNT user equipment should incorporate all available space navigation signals to resist the effects of space attacks. A GPS receiver computes a navigation solution utilizing the US GPS constellation as the sole navigation source. A "guerrilla" PNT receiver would calculate a navigation solution from US, European, Chinese, Russian, and other space PNT constellations. This receiver could resist a GPS jammer by switching over to the other available space navigation messages. To defeat a "guerrilla" receiver, counterspace equipment would need to deny all nations' PNT constellations, not

43. Che Guevara, *Guerrilla Warfare*, 3rd ed. (New York, NY: Scholarly Resources Books, 1997), 58-59.
44. Ibid., 52-53.

just the US GPS satellites. Senior Chinese government officials indicated Chinese precision-navigation terminals will be augmented with "guerrilla" chipsets receiving satellite signals from the Chinese, American, Russian, and European navigation constellations.[45] The US user equipment is expanding but typically limited to American and one other country's navigation signals.[46] The United States should leverage all nations' navigation signals.

"Guerrilla" user equipment also includes intelligence collection sources. Guerrilla fighters need sound knowledge of the environment.[47] ISR satellites provide a nation with global situational awareness. These "eyes and ears" satellites will be some of the first targets in a conflict.[48] Guerrillas can maintain sound knowledge through what they observe and what the local population shares with them. Irregular warfare strategists should share and collect ISR data with all friendly sources. The number of powerful space-faring friends and allies the United States has is a huge asset to leverage. For instance, the European Space Agency and others participate in the Copernicus program sharing powerful satellite imagery. This program includes roughly 30 satellites contributing very high-resolution synthetic aperture radar, optical, and multi-spectral information.[49] The United States can develop processes to share its robust satellite ISR data with partnerships like these and in return receive the same exchange of information products to ensure continued access to ISR information from space.

---

45. Peter B. de Selding, "China Official: Beidou Will Receive GPS, Glonass, Galileo, Signals," *SpaceNews*, 6 February 2015, http://spacenews.com/china-official-beidou-gear-will-receive-u-s-russian-and-european-gnss-signals/.
46. GPS World staff, "Draganfly UAS now use GPS + GLONASS," *GPS World*, 27 April 2016, http://gpsworld.com/draganfly-uas-now-use-gps-glonass/.
47. Ibid., 52.
48. Despite United States best efforts to kept ISR satellites masked from the international community within the National Reconnaissance Organization, other nations are well aware of these satellites. In 2009, the Chinese conducted a laser test illuminating one of the United States NRO satellites.
Warren Ferster and Colin Clark, "NRO Confirms Chinese Laser Test Illuminated U.S. Spacecraft," *SpaceNews*, 3 October 2006, http://www.spacenews.com/article/nro-confirms-chinese-laser-test-illuminated-us-spacecraft.
49. European Space Agency, "Copernicus Observing the Earth," ESA.int, accessed 15 April 2016,
http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Contributing_Missions_overview.

A "guerrilla" mindset would purchase information on the open market when available. Advancements in the earth observing commercial industry will continue adding opportunities to additional ISR sources. Civilian companies such as Planet Labs, established in 2010, now operates the largest earth-observing constellation in history. This company's LEO constellation, with over 100 small satellites launched, observes the entire globe every day and provides services capable of pushing same day images.[50] While the United States has sophisticated ISR satellites, there is a high probability these satellites will be targeted. Developing the relationships and "guerrilla" user equipment to receive uninterrupted ISR information from friends, allies, and commercial companies will create the flexibility for continued situational awareness in any environment.

"Guerrilla" user equipment for satellite communications would ensure communication pathways anywhere in the world, including contested environments. The key to assured pathways lies in the concept of mobility. French philosopher and journalist Regis DeBray documented, in *Revolution in the Revolution*, mobility as a fundamental principle of guerrilla forces over a repressive army.[51] To maintain space communications when facing an electronic jamming environment, "guerrilla" user equipment needs to increase mobility across the electromagnetic spectrum.

Coordinating frequency changes across the available spectrum enhances the mobility of "guerrilla" user equipment and the probability to overcome contested environments. There is a plethora of available commercial satellite communication bandwidth to use. Training and developing procedures to maximize the available spectrum is mandatory to ensure assured pathways. In 2000, a RAND study detailed how high-altitude aircraft can maintain satellite communications with electronic jammers directly beneath the plane by switching to low elevation satellites below the line of sight of the jammers.[52]

---

50. Planet Labs, "About," Planet Labs, accessed 15 April 2016, https://www.planet.com/about/#approach.
51. Regis Debray, *Revolution in the Revolution? Armed Struggle and Political Struggle in Latin America* (New York, NY: Grove Press Inc., 1967), 44.
52. Tim Bonds, et al., *Employing Commercial Satellite Communications: Wideband Investment Options for the Department of Defense*, (Santa Monica, CA: RAND Corporation, 2000), 75-83.

Former Air Force officer, MIT and Purdue University electrical engineering graduate, Don Wilcoxson, describes how current commercial satellites and commercial-off-the-shelf modem equipment can be optimized for protected communication through maneuvering across large bandwidth, exploiting narrow spot beams and geographically separated gateways.[53] The ideas above only touch the tip of the iceberg on options available for a "guerrilla in space" and does not even include innovative options such as frequency hopping between satellites.

Space guerrilla capabilities would incorporate more than just user equipment options. For instance, on-orbit guerrilla forces increases the ability to provide a minimum essential space effect. Covert small satellites, concealed hosted payloads, low detectable signals all represent "guerrillas in space" indirect force options available to disperse and concentrate for an irregular warfare space strategy.

Advancing small satellite technology presents an opportunity as the satellite population size increases. Five-year forecasts, at the time of this writing, estimate that an additional 1,000 nanosatellites will be launched by 2019.[54] Small satellites perform a variety of mission areas including satellite "swarm formations," hosted payloads, and future developments exploring sub-one-meter resolution with optical and synthetic aperture radar imaging.[55] Identifying the intent and actual mission of every satellite becomes incredibly difficult as the number of satellites increases on orbit.

Affordable launcher technology development should satisfy growing small satellite demands of government and commercial organizations. DARPA is

53. Don Wilcoxson, "Advanced Commercial Satellite Systems Technology for Protected Communication," 2011 Military Communications Conference-Track 6-Department of Defense Programs, 2011, 2280-2285, https://www.viasat.com/sites/default/files/legacy/Government%20satcom%20systems/AdvCommericalSatforProtectedComms.pdf.
54. Technology Quarterly Q2 2014, "Nanosats are go!," *Economist*, 7 June 2014, http://www.economist.com/news/technology-quarterly/21603240-small-satellites-taking-advantage-smartphones-and-other-consumer-technologies.
55. Kiyonobu Ono, Takashi Fujimura, Toshiaki Ogawa, and Tsunekazu Kimura, "Small Sar Satellite Using Small Standard Bus," Proceedings of the AIAA/USU Conference on Small Satellites, Technical Session I: Mission Payloads and their Applications, 2011, 4-5, http://digitalcommons.usu.edu/smallsat/2011/all2011/11/.

developing the XS-1 reusable spaceplane potentially capable of delivering small satellites into orbit once a day at a tenth of current rocket costs.[56] The Airborne Launch Assist Space Access (ALASA) program represents another DARPA initiative to launch small satellites from aircraft into any orbit from any major airport around the world for a fraction of the costs.[57] Additionally, commercial companies Virgin Galactic, Boeing, Garvey Spacecraft, and Swiss Space Systems are investing in sub-orbital and air-launch concepts to meet this growing small satellite launch demand.

The projected increase in the number of satellites coupled with launch capacity present opportunities to camouflage satellite capabilities on-orbit. A leading irregular warfare scholar, Professor James Kiras, states "to have a reasonable chance of success in any type of irregular warfare, groups must keep their activities hidden from their adversary for as long as possible, so as not to be detected, tracked and destroyed."[58] The United States can deceive potential adversaries with various small satellite launches and disguise the missions' true purpose. Delaying the revelation of a small satellite's location is another option to insert mission essential space capabilities on-orbit to complicate an adversary's chances of negating US space assets.

While potential adversaries tightly monitor American launches and the objects released, the X-37B spaceplane could provide the United States a way to employ small satellites undetected in the future. The X-37B Orbital Test Vehicle is an experimental unmanned space program of a reusable spacecraft.[59] Boeing advertises that the vehicle possesses a cargo bay more than sufficient to

---

56. David Axe, "Pentagon Preps for Orbital War With New Spaceplane," *The Daily Beast*, 3 August 2015, http://www.thedailybeast.com/articles/2015/08/03/pentagon-preps-for-orbital-war-with-new-space-plane.html.
Elizabeth Howell, "XS-1: DARPA's Experimental Spaceplane," *Space.com*, 1 May 2015, http://www.space.com/29287-xs1-experimental-spaceplane.html?adbid=10152809779056466&adbpl=fb&adbpr=17610706465&cmpid=514630_20150514_45741516&short_code=2zjo7.
57. Michael S. Kelly, "Airborne Launch Assist Space Access (ALASA)," Defense Advanced Research Projects Agency, accessed 15 April 2016, http://www.darpa.mil/program/airborne-launch-assist-space-access.
58. James D. Kiras, "Irregular Warfare," in *Understanding Modern Warfare*, David Jordan et al., (New York, NY: Cambridge University Press, 2008), 232.
59. United States Air Force, "X-37B Orbital Test Vehicle," United States Air Force, 17 April 2015, http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104539/x-37b-orbital-test-vehicle.aspx.

house small satellites.[60] Additionally, space observers claimed the vehicle could change orbits and indicate periods of time when the observers could not track the vehicle.[61] If this is true, then the X-37B could house various small satellites and change orbits when in a low observable position discreetly deploying covert satellites. If the United States desires to camouflage small satellite deployments, the X-37B presents an option in the future to combine mobility with concealment to field "guerrilla" satellites necessary to ensure minimal level space support for terrestrial forces.

Hosted payloads on allied and commercial satellites is another option to conceal the dispersal of space capabilities. British officer, T.E. Lawrence, relied on speed and the widest distribution of forces as a way to help the Arab revolt against the Turks in World War I.[62] In *The Evolution of a Revolt*, Lawrence reveals a key insight into his dispersal strategy was "the virtue of irregulars lay in depth, not in face, and that it had been the threat of attack by them upon the Turkish northern flank which had made the enemy hesitate for so long."[63] Extrapolating the "in depth" concept, hosting military payloads across allied and commercial satellites provides the United States with increased depth to the possibility of maintaining minimum essential space capabilities. Instead of attacking railway supply lines, hosted payloads could fire space signals in depth to pierce a contested space environment. Hosted payloads could pair with allied and commercial satellites under an alias not related to the United States. Cover stories and aliases are nothing new to warfare and could extend

60. Boeing, "X-37-B Orbital Test Vehicle," Boeing, accessed 26 April 2016, http://web.archive.org/web/20150321121050/http://www.boeing.com/boeing/defense-space/ic/sis/x37b_otv/x37b_otv.page.
61. Leonard David, "Secret X-37B Space Plane Has Changed Orbit," *Space.com*, 24 August 2010, http://www.space.com/9000-secret-37b-space-plane-changed-orbit.html.
News.com.au, "US military's top secret X-37B shuttle 'disappears' for two weeks, changes orbit," *News.com.au*, 25 August 2010, http://www.news.com.au/technology/us-militarys-top-secret-x-37b-shuttle-disappears-for-two-weeks-changes-orbit/story-e6frfro0-1225909738276.
62. Lawrence Freedman, *Strategy: a History* (New York, NY: Oxford University Press, 2013), 181-182.
63. T.E. Lawrence, *The Evolution of a Revolt*, (Fort Leavenworth, KS: Combat Studies Institute Press, 2012), 4. http://usacac.army.mil/cac2/cgsc/carl/download/csipubs/lawrence.pdf.

into the space domain as a way to deny a potential adversary the ability to negate US space effects.

Low detectable signals from on-orbit assets is a way to use the electromagnetic spectrum to assure information pathways. T.E. Lawrence describes his approach to irregular warfare as gas: a vapor without a front or back, rendering a regular solider helpless and without a target.[64] Different signal waveforms such as direct spread sequence signals (DSSS) can analogously mimic the "gas" concept. DSSS signals occupy more than the necessary amount of bandwidth and typically hide within the spectrum noise floor making the signal more resistant to unintentional and intentional interference.[65] Covertly using a DSSS in a "war-time" only setting, where one broadcasts a signal only when needed, would significantly dampen the ability to deny a space signal. The United States can increase the survivability of its space assets in a contested environment by using low detectable signals in a "war-time" only setting.

Space guerrilla capabilities would incorporate user equipment and on-orbit options to increase the ability to provide a minimum essential space effect. The United States could adopt a "guerrilla" user equipment mindset across PNT, ISR, and SATCOM mission areas by leveraging allies, friends, and commercial companies. The future trends indicate the United States is ideally positioned to create a "guerrilla" indirect force in space through small covert satellites, concealed hosted payloads, low detectable signals to disperse and concentrate with an irregular warfare space strategy.

In sum, the characteristics of an irregular warfare strategy are to create an identification problem for a potential adversary through dispersing and concentrating direct and indirect forces. An unconventional approach to space strategy leverages a strategically defensive posture while tactically creating a guerrilla capability. The "guerrilla in space" concept provides terrestrial forces with a minimum essential level of force enhancements from user equipment capable of exploiting foreign and commercial satellite signals and covert

64. Ibid., 8.
65. Simon Haykin, *Communication systems*, 4th ed. (New York: NY, John Wiley & Sons, 2001), 499-500.

payloads on small satellites when one's main space systems face an overwhelming counterspace adversary. The United States is in a prime position to create a significant identification problem for any potential foe seeking to deny the United States access to space assets. Combining indirect guerrilla space forces with existing US space assets presents a potential adversary with a complex targeting dilemma to overpower.

The Means of Guerrilla Space Warfare: Shaping Norms

When there is an identification problem in warfare, actors use violence in a selective and indiscriminate manner. Stathis Kalyvas describes the dichotomy of the two forms of violence in *The Logic of Violence in Civil War*. Belligerents contemplate using indiscriminate violence initially because it appears to be a "cheaper" solution when faced with difficulties identifying an enemy; combatants' long-term interest, however, are best served through selective violence.[66] Indiscriminately using violence increases the risks of fratricide and creating more enemies.

Actors have the option to use indiscriminate and selective violence in space warfare. Examples of indiscriminate violence in space are ASATs, WMDs, and brute force jamming. Kinetic ASATs have the potential to generate massive amounts of orbital debris as demonstrated by the 2007 Chinese ASAT test.[67] The additional debris can potentially collide with other friendly, adversary, or neutral spacecraft. A nuclear explosion in space can destroy the targeted and non-targeted satellites by frying on-board electronics with hazardous charged particles burst. Brute force jamming can temporarily negate space signals no matter the intended target by denying large swaths of bandwidth. In 2014, a commercial satellite company accused the Ethiopian government of using brute force jamming against its satellites temporarily denying the suspected space signal and other signals on the satellite's transponder.[68] The examples above

66. Stathis N. Kalyvas, *The Logic of Violence in Civil War* (New York, NY: Cambridge University Press, 2009), 171-172.
67. Marc Kaufman and Dafna Linzer, "China Criticized for Anti-Satellite Missile Test," *The Washington Post*, 19 January 2007, http://www.washingtonpost.com/wp-dyn/content/article/2007/01/18/AR2007011801029.html.
68. Peter B. de Selding, "Eutelsat Blames Ethiopia as Jamming Incidents Triple," *SpaceNews*, 6 June 6 2014, http://spacenews.com/40818eutelsat-blames-ethiopia-as-jamming-incidents-triple/.

are some indiscriminate attack options available for decision makers to use in space.

Selective violence in space warfare specifically limits the damage to the intended target. Some selective violence examples in space are ASATs and targeted jamming. While kinetic ASATs generate debris, if used against a de-orbiting spacecraft the debris will burn up in the atmosphere as the 2008 US modified SM-3 missile launch destroying a malfunctioning satellite demonstrated.[69] Targeted jamming specifically negating the intended space signal without affecting another broadcast is a form of selective violence. If the 2014 Ethiopian jamming example mentioned previously had attenuated the jamming power and refined the bandwidth parameters only affecting the desired targeted signal, then this refined jamming technique would have been a temporary selective space attack example.

Understanding indiscriminate and selective violence in space is critical to developing an advantageous unconventional strategy. Earlier in the chapter, the spectrum of violence in space described reversible and non-reversible options for a decision maker. When using violence in a setting that is hard to identify targets, indiscriminate and selective forms of violence become potential mechanisms to gain control. Indiscriminate violence tends to serve counter to an actor's long-term interest, so selective violence is the preferred option.[70] For an irregular warfare space strategist, creating an environment where it is difficult to target one's space assets is ideal for a defensive strategy. Therefore, for the United States to create an advantageous future in space, the United States should shape international norms towards reversible selective violence in space and then field guerrilla space capabilities to create an identification problem for any potential adversary.

A fish trap serves as a deceptively ripe metaphor for how the United States can employ an advantageous irregular space strategy. In *Out of the Mountains the Coming Age of the Urban Guerrilla*, David Kilcullen describes how various groups create "fish traps" to control people. "Like real fish traps, these

69. Lt Col James Mackey, "Recent US and Chinese Antisatellite Activities," *Air and Space Power Journal* 23, no. 3 (Fall 2009): 82-93, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj09/fal09/fal09.pdf.
70. Kalyvas, *The Logic of Violence in Civil War*, 171-172.

metaphorical traps are woven of many strands—persuasive, administrative, and coercive. Though each of the strands may be brittle, their combined effect creates a control structure that's easy and attractive for people to enter, but then locks them into a system of persuasion and coercion: a set of incentives and disincentives from which they find it extremely difficult to break out."[71] The fish trap's strength is derived from its deceptively flimsy structure.

The United States should develop a "fish trap" in space comprised of three components: a normative system, incentives, and disincentives. A normative system in space serves as the administrative aspect of the "fish trap" and needs to be based on predictability and functionality. Incentives become the persuasive portion to join a normative system requiring an enticing bait to convince friends and potential foes to enter. The disincentives of the "fish trap" structure are coercive and should compel all actors there are no benefits for trying to exit and only pain awaits.

The extension of violence into outer space has the potential to affect all space-faring actors. Collateral damage dangers are one commonality for all actors receiving benefits from space assets. The Outer Space Treaty of 1967 only limits placing weapons of mass destruction in space.[72] Mass destruction to the threat of force represents a significant range of decision options on the spectrum of violence in space. Indiscriminate and non-reversible violence has the potential to cause devastating damage to all orbital architectures while selective and reversible violence offers an opportunity for an actor to achieve a desired political objective without adverse implications of indiscriminate, non-reversible violence. The United States should shape the international norms to reflect what it perceives to be responsible behavior in space, which should include reversible selective violence to minimize collateral damage.

Establishing a predictable and functional normative system in outer space begins with a Code of Conduct. Developing a functional Code of Conduct for violence in space in which space-faring nations agree, shrinks the

---

71. David Kilcullen, *Out of the Mountains: The Coming Age of the Urban Guerrilla*, (New York, NY: Oxford University Press, 2013), 117.
72. UN General Assembly, Resolution 2222 (XXI), "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," 19 December 1966, Article IV, http://disarmament.un.org/treaties/t/outer_space/text.

unpredictability that exists in what conflict can look like in outer space. Security analyst Elbridge Colby recently outlined clear and reasonable criteria for "Rules of War" in space that would benefit the United States and others. His suggested Code of Conduct follows:

Principles for International Conduct in Space:

- Being the first to carry war into space is escalatory and irresponsible.
- Kinetic attacks that cause lasting damage to humanity's ability to exploit space abilities are prohibited.
- Attacks on or interruptions of strategic space assets would be construed as highly escalatory, and should be presumptively disfavored.
- Satellites and space assets not directly and substantially involved in a conflict are not legitimate targets for attack.
- Attacks in space justify responses outside of space.[73]

Colby's suggested Code of Conduct for space violence provides a foundation for a predictable and functional normative system. One needed modification to account for reversible non-kinetic attacks would be to remove the irresponsible language from Colby's first statement. Jamming another actor's satellite is escalatory; it is not irresponsible, however, if aligned with political intent. Colby's Code of Conduct recognizes the potential for violence in outer space and attempts to constrain the destructive impacts of a space attack. Additionally, it accounts for the nature of warfare in space as limited by justifying retaliation attacks outside of space. Furthermore, it does not put any restraints on a nation adopting a defensive irregular warfare strategy. For these reasons and others, the United States should attempt to shape a normative system in space in line with Colby's recommendations.

Sustainability of the space environment and existing counterspace weapon systems provide all space-faring actors the incentives to agree to the suggested "Rules of War" in space. Limiting kinetic attacks that cause lasting debris in the space domain helps create an environmentally sustainable outer space. All actors who have invested in orbital architectures have future aims in

73. Elbridge Colby, "From Sanctuary to Battlefield: A Framework for a U.S. Defense and Deterrence Strategy for Space," Center for a New American Security, 27 January 2016, 21, http://www.cnas.org/sites/default/files/publications-pdf/CNAS%20Space%20Report_16107.pdf.

space to generate benefits from space effects; thus, they have a common interest to preserve the domain for future use. All conflicts are temporary, and violence in space has the potential to leave considerable debris on orbit for decades. Limiting the damaging effects of violence in outer space creates a sustainable environment and rationale for agreeing to "Rules of War" in space.

Incentives exist for actors with robust counterspace equipment to accept the "Rules of War." China and Russia represent two nations who have developed an impressive array of counterspace capabilities. China continues to develop and acquire counterspace weapon systems for a multi-layered offensive approach to its anti-access and area-denial strategy.[74] Russia recently advertised an electronic satellite jammer capable of denying all satellite communication frequencies.[75] Both Russia and China invest funds for developing counterspace weapon systems. The proposed "Rules of War" in space does not prohibit their counterspace portfolio from targeting orbital architectures.

International backlash would create a disincentive to ignore the "Rules of War" in space. The political risks for unleashing a space attack magnify if all the great powers agree to a common standard of behavior in outer space. If an actor considers ignoring the "Rules of War" in space, a coalition response could provide the coercive impetus for abiding by the "rules." Additionally, if the United States develops a "guerrilla in space" capability, the United States could provide a coalition with an unrivaled military force enhanced by space assets. The potential response by a US-backed coalition provides a significant disincentive to ignore "Rules of War" in space.

The "Rules of War" in space provides a functional structure for all nations around the world. It creates the bait to lure in friends and foes into a predictable normative system by focusing on a sustainable outer space after conflict and not nullifying world powers who invested in counterspace weapon systems. Additionally, the "fish trap" has a coercive element by providing the

74. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014,* (Washington, DC: Office of the Secretary of Defense, 24 April 2014), 32.
75. "Invisible warfare: Russia touts second-to-none jamming equipment," *Sputnik News*, 7 March 2016, http://sputniknews.com/russia/20160307/1035897115/russia-electronic-warfare-systems.html.

international community a justified reason to form a coalition to punish any violators. The United States would be in an advantageous position if it promoted this system because it could still achieve the three historically enduring goals in space: freedom of action, foster international cooperation, and control the domain when desired.

The Means of Guerrilla Space Warfare: Strategic Narrative

A strategic narrative is required to convince the various audiences to accept a "Rules of War" proposal. Emile Simpson provided a blueprint for how to develop a strategic narrative across various strategic audiences when engaged in an irregular war. He stated the narrative should explain actions before, during, and after conflict using the flow of history with an appeal to a moral component focused on the future.[76] The following paragraphs attempt to capture some initial elements of a strategic narrative for limited space warfare.

Responding to attacks against orbital architectures is justified because nations have the inherent right of self-defense. At the same time, actors need to recognize the potential for conflict to extend into outer space and must consider the environmental ramifications. When space attacks are used, violence needs to be responsible and ensure outer space will be available for future generations.

History shows humankind's desire for a "sanctuary" in space, but politics have always intruded on such idealist notions. Where there is politics, there is potential for violence. Throughout time, empires and states used land power to occupy and conquer territory for political objectives. One of the earliest civilizations of the world, Mesopotamia, chronicles constant clashes of warriors to unify a region under one leader between 2334-2279 BCE.[77] Naval power morphed from a transportation mechanism to an instrument of violence.[78] The eighteenth century represented a period dominated by Britain's capability to turn naval vessels into fleets of warships securing vital sea-lanes.[79] In less

76. Emile Simpson, *War from the Ground Up: Twenty-First-Century Combat as Politics* (New York, NY: Oxford University Press, 2013), 225.
77. Joshua J. Mark, "War," Ancient History Encyclopedia, 2 September 2009, http://www.ancient.eu/war.
78. Larry H. Addington, *The Patterns of War Since the Eighteenth Century*, 2nd ed. (Bloomington, IN: Indiana University Press, 1994), 7-12.
79. Ibid., 7-9.

than 50 years, airpower morphed from simple aerial contraptions, like the Wright Flyer, to aircraft capable of delivering an atomic bomb. In today's information age, spacepower facilitates the transfer of data around the globe. Despite the notion that space is a sanctuary, history tends to support the inevitable extension of violence into space.

If conflict is inevitable, then humankind needs to ensure space warfare matches the intent of humans' historical experience in space; one of military restraint.[80] Logically, the nature of war in space is limited since the domain is strategically isolated from actors' homelands nor does a space attack represent an existential threat to any nation. Humankind should do its best to ensure the nature of war in space stays limited by advocating for selective reversible violence when the political context demands such response.

Adopting an explicit, escalatory-limited violence standard in space as a means to achieve policy objectives preserves humankind's future in space. If a nation's desire to achieve a political objective matches the escalatory notion space attacks bring with it, then a nation should not be stopped as long as the space attack is responsible. Permanently eliminating humankind's opportunities to explore and derive benefits from outer space is irresponsible and should be forbidden.

The future in space is something all nations should not lose sight of; clean renewable energy is nearly upon us with space-based solar power.[81] Colonizing the moon and other celestial bodies could represent an epic change to humankind's evolution as humans become an interplanetary species.[82] These notions of the future drive a need to ensure when conflict extends into space, that violence employed is in a responsible manner through highly discriminating temporary and reversible means.

In sum, actors use indiscriminate and selective violence when there is an identification problem in warfare. An opportunity exists to develop an

---

80. James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 2nd ed. (Stanford, CA: Stanford University Press, 2008) 326.
81. National Space Society, "Space Solar Power Limitless Clean Energy From Space," National Space Society, 11 April 2016, http://www.nss.org/settlement/ssp/.
82. James Fallows, "The Coming Age of Space Colonization," *The Atlantic*, 20 March 2013, http://www.theatlantic.com/technology/archive/2013/03/the-coming-age-of-space-colonization/273818/.

unconventional strategy to exploit an irregular warfare context. The United States can capitalize on such a possibility in space by shaping international norms towards reversible selective violence in space and then fielding guerrilla space capabilities to create an identification problem for any potential adversary. Establishing a predictable and functional normative system through a Code of Conduct in outer space begins the process to create an advantageous situation in outer space for the United States. Sustainability of the space environment and existing counterspace weapon systems provide all space-faring actors the incentives to agree to the suggested "Rules of War" in space. International backlash cements a disincentive for ignoring the "Rules of War" in space. A strategic narrative is required to convince the various audiences to accept a "Rules of War" proposal. A compelling vision for a space warfare narrative is military restraint through selective reversible space attacks because it is environmentally sustainable and deconflicts with future human space endeavors.

Conclusion

In conclusion, the United States should adopt a defensive irregular warfare space strategy for three reasons. First, a defensive irregular warfare space strategy aligns with the limited nature of space warfare. The strategic isolation criteria to the space domain reveals conflict in space tends to be more limited than unlimited because of its geographical separation from Earth and the variance actors place on the political importance of orbital architectures. Second, a defensive irregular warfare space strategy creates an identification problem for a potential adversary by implementing the guerrilla concept. The "guerrillas in space" concept deploys covert payloads and fields robust user equipment to provide a survivable element to the US space portfolio. Finally, there is an opportunity to shape the character of future conflict in outer space for the benefit of all space-faring nations. Establishing space "Rules of War" constrains the use of violence to selective temporary and reversible means. Additionally, the rules create a predictable and functional normative system that will enable the ingenuity required to achieve humankind's outer space goals.

Sun Tzu revealed that a key to victory in warfare was through maneuver using direct and indirect forces.[83] He stated direct forces engage the enemy while the indirect forces win the battle.[84] "Guerrillas in space" represents indirect space forces for a commander to leverage in space warfare. The United States should adopt an irregular warfare space strategy to help secure victory in a future contested environment. The United States should employ "guerrillas in space" and shape international norms to limit space attacks to selective reversible means. Combining these two actions sets the trap for an enduring and advantageous structure for the United States.

83. Sun Tzu, *The Illustrated Art of War*, trans. Samuel B. Griffith (New York, NY: Oxford University Press, 2005), 123, 161.
84. Sun Tzu, *The Art of War*, trans. Samuel B. Griffith (New York, NY: Oxford University Press, 1971), 91.

Chapter 5
Conclusion

War and peace are inseparable. Wars are fought to attain a better state of peace and in the periods between wars, preparations are made for the next. The notion of a purely peaceful era when armed forces lay down their weapons seems infeasible. Actors in the international system compete and when necessary, resort to conflict. Since there is no governing world authority to mitigate conflict, actors engage in war when nonviolent means fail. Thus, actors must always be prepared for war because their survival depends on it.

War is simply politics by other means.[1] Clausewitz conceptualizes war in three parts: politics, violence, and chance.[2] Politics provides the reason an actor chooses to engage in war. Violence describes the act of armed engagements. Chance adds the unpredictable component to war. When all three parts are present, war is possible.

Actions in space are merely reflections of earthly politics inextricably linked to diplomatic, informational, military, and economic interests. A historical analysis of US space endeavors reveals a clear link to policy. The United States pursued political objectives in space since the dawn of the satellite. The US enduring political aims in space, regardless of the presidential administration, focuses on maintaining US freedom of action, seeking ways to cooperate with other space actors, and controlling space when required.

Actions in space can be violent. Violence intends to harm, disable, damage, or destroy an intended target. Force, energy, and weaponized code are the three methods of violence in space. Violence in space, however, is less physical, less emotional, and less symbolic than in traditional domains. Actors in the international system can use violence in outer space as a tool to achieve political and military objectives.

1. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 87.
2. Clausewitz, *On War*, 89.

Space warfare is a component of war. Actions in space are merely extensions of politics. Those actions can be violent. The chance taken to achieve political objectives will always be unpredictable in any domain of warfare. Thus, actors must prepare for the possibility of battle in any form, including space warfare.

Proliferating counterspace weapons and potentially changing international norms present a challenge to US enduring aims in space. Counterspace weapon systems presents a threat to the United States' ability to maintain freedom of action in outer space during peace and war. The proliferation of these weapons are potentially leading to international actors challenging the overflight rights of satellites to operate without purposeful interference.[3] Space attacks against US satellites are a real possibility. If the United States enters a war with an adversary who possesses a robust counterspace weapons portfolio, then the chances of controlling the space domain significantly decreases and affects America's preferred style of fighting. These two challenges present strategists an opportunity to explore other forms of warfare for potential solutions.

Irregular warfare utilizes methods that help a weaker belligerent survive. If a nation plans to leverage satellites in war, it must acknowledge satellites' inherent disadvantages and look for strategies to overcome them. Irregular warfare's nature, character, and means provide a framework for a space strategist to use. Irregular warfare's nature tends to employ violence in a limited versus absolute fashion because of fog, friction, and uncertainty. Irregular warfare's character creates an identification problem for adversaries by using direct and indirect forces to concentrate and disperse simultaneously. Indiscriminate and selective violence coupled with strategic narratives represent the means to control areas embroiled in irregular warfare. Due to satellites' inherent vulnerabilities, irregular warfare concepts of identification, use of

3. Bill Gertz, "China, Russia Planning Space Attacks on U.S. Satellites," *The Washington Free Beacon*, 16 March 2016, http://freebeacon.com/national-security/china-russia-planning-space-attacks-on-u-s-satellites/.
Sydney J. Freedberg Jr., "US Jammed Own Satellites 261 times; What If Enemy Did?," *Breaking Defense*, 2 December 2015, http://breakingdefense.com/2015/12/us-jammed-own-satellites-261-times-in-2015-what-if-an-enemy-tried/.

guerrilla forces and strategic communications emerge as unorthodox concepts to apply in the development of a US space strategy.

To solve these challenges, the United States needs a coherent strategy capable of setting advantageous conditions to attain the US enduring political objectives. This can not be done with a purely diplomatic solution. A comprehensive solution will include the military and the recognition for space warfare in a future conflict. Due to the US leadership role on the international stage, any space warfare strategy should demonstrate restraint.

There are three reasons a defensive irregular warfare space strategy provides the United States the option to create advantageous conditions in space given the emerging challenges. First, this space strategy aligns with the limited nature of warfare in space. The strategic isolation of the space domain from a nation's homeland reveals conflict in space tends to be more limited than unlimited because of its geographical separation from Earth and the variance actors place on the political importance of orbital architectures.

Second, a defensive irregular warfare space strategy creates an identification problem for a potential adversary by implementing the guerrilla concept. The "guerrillas in space" concept deploys covert payloads and fields robust user equipment to provide a survivable element to the US space portfolio.

Finally, there is an opportunity to shape the character of future conflict in outer space for the benefit of all space-faring nations. Establishing space "Rules of War" constrains the use of violence to selective reversible means. Additionally, the rules create a predictable and functional normative system that will enable the ingenuity of humanity's outer space developments.

A defensive irregular warfare space strategy allows the United States to maintain freedom of action in space. In peacetime, the United States would retain the preponderance of orbital assets and have access to the expanding commercial market. In a potential war, the United States would maintain an adjusted freedom of action with minimal essential space capabilities from covert payloads and robust user equipment.

A defensive irregular warfare space strategy enhances the US enduring cooperation aim. The strategy requires the United States to partner with allies,

friends, and the commercial industry. Through hosted payloads and newly formed information sharing arrangements, the United States will continue to promote the benefits of cooperation while enhancing national security in space.

A defensive irregular warfare space strategy only partially improves US ability to control the space domain. This strategy focuses on ensuring unimpeded access to space for the United States. It does not address the portion of control that denies a potential adversary access to space capabilities.

Implications

The US National Security Space Strategy (NSSS) establishes five strategic approaches to achieve the enduring US political objectives. Promoting responsible, peaceful, and safe use of space is the first strategic approach.[4] The US NSSS seeks to use transparency and confidence-building measures and norms of behavior for responsible space operations as the means to shaping the international environment.[5] An irregular space strategy would support this notion as a way to create an advantage over any potential adversary. Establishing space "Rules of War" to constrain space attacks to selective temporary and reversible means would be the sought after international norm.

The second US NSSS strategic approach is providing improved US space capabilities.[6] The US NSSS establishes a range of general areas to pursue improved space technologies to include partnerships across academic, industry, and international opportunities.[7] An irregular space strategy seeks to exploit various space developments especially within the small satellite industry and user equipment developments. From this take, an irregular space strategy supports this US NSSS strategic approach.

The third US NSSS strategic approach is partnering with responsible nations, international organizations, and commercial firms.[8] The US NSSS implies that entangling with other space actors and organizations creates a

4. Department of Defense and Office of the Director of National Intelligence, *National Security Space Strategy: Unclassified Summary* (Washington, DC: Secretary of Defense and Director of National Intelligence, January 2011), 5.
5. Ibid., 5.
6. Ibid., 6.
7. Ibid., 6-8.
8. Ibid., 8.

responsible and peaceful norm for all.[9] An irregular space strategy captures this process as a way to build administrative habits in a functional system. The more interactions space actors have with each other, the more opportunity to influence and collaborate.

The fourth US NSSS strategic approach is preventing and deterring aggression against space infrastructure that supports US national security.[10] The US NSSS views promoting responsible norms, partnerships, increasing orbital architecture resiliency, and retaining the right to respond in self-defense as elements to contribute to this approach.[11] An irregular space strategy supports these elements through creating an identification problem for a potential adversary. Using covert satellites, hosted payloads, and robust user equipment are the suggested means to prevent and deter aggression against US space architectures. Covert satellites and robust user equipment are not included in the US NSSS and represents an opportunity to explore.

The fifth US NSSS strategic approach prepares to defeat attacks and operate in a degraded environment.[12] The US NSSS suggests resilient orbital architectures, cross-domain solutions, and accessing partners' capabilities as ways to function in a degraded environment.[13] An irregular space strategy whole-heartedly agrees with preparing for space warfare in the future. Creating an identification problem for an adversary's targeting calculus by developing robust user equipment and covert payloads are the added addition to the suggestions offered in the US NSSS.

The original hypothesis of this thesis is that an irregular warfare lens would yield a more advantageous strategy to deter, deny, and defeat adversary attacks against US and allied space systems proves to be conditionally false. The process of developing an irregular space strategy arrived at similar suggestions already residing within the US NSSS. The current US NSSS is a comprehensive space strategy to accomplish the US enduring political

9. Ibid., 8-9.
10. Ibid., 10.
11. Ibid., 10.
12. Ibid., 11.
13. Ibid., 11.

objectives. The three considerations below offer suggestions from an irregular warfare perspective to enhance the current US NSSS.

Considerations

An irregular space strategy discovered three considerations for refining the US NSSS. First, pursue strategies that create an identification problem for any potential adversary to target US space-derived services. Inserting doubt into an opponent's ability to deny the United States access to space-derived services will help deter, deny, and defeat adversary attacks.

Second, shape potential space conflict through international norms to change the agreed upon bar of no weapons of mass destruction in orbit down to only selective temporary and reversible means as acceptable in space warfare. This will ensure the preservation of the space environment after any conflict. The current and future opportunities solidify the notion space is a strategic asset for humankind.

The final consideration is covert satellites and robust user equipment represents opportunities for improving the United States' ability to deter, deny, and defeat adversary space attacks. Employing some defensive deception techniques in space are against the transparency objectives of US policy but could go a long way in ensuring political aims are achievable.

This thesis scratched the surface of how to apply irregular warfare concepts into a space strategy. The purpose of the research was to approach space strategy from a different theoretical base than previously explored. The United States faces significant challenges in trying to achieve its three enduring objectives. Throughout the research project, multiple questions arose which this paper failed to address. Below are questions that require further analysis.

- Are there any benefits to pursuing an offensive irregular warfare space strategy?
- How does an actor ensure a covert payload remains secret?
- What are the ramifications for integrating various space PNT signals into one receiver?
- What is the potential response of other nations when space "Rules of War" are proposed and eventually accepted?

- Does promoting selective temporary and reversible violence in space lead to an increase of space attacks against orbital architectures?

An irregular space strategy would create the options for the United States to accomplish its space objectives. Additionally, the strategy can continually adapt to the current contextual realities to maintain an American asymmetric advantage in space. This thesis proposed a new lens of space theory to shape a US strategist's perspective. An irregular space warfare lens enables a strategist to think about war from the high ground down.

Bibliography

Books

Addington, Larry H. *The Patterns of War Since the Eighteenth Century*. 2nd ed. Bloomington, IN: Indiana University Press, 1994.

Balts, Maj Keith W. "The Next Evolution for Theater Space Organizations: Specializing for Space Control." In *Space Power Integration Perspectives from Space Weapons Officers*, edited Lt Col Kendall K. Brown, 117-141. Maxwell AFB, AL: Air University Press, 2006.

Biddle, Stephen. *Military Power: Explaining Victory and Defeat in Modern Battle.* Princeton, NJ: Princeton University Press, 2006.

Bonds, Tim, Michael G. Mattock, Thomas Hamilton, Carl Rhodes, Michael Scheiern, Philip M. Feldman, David R. Frelinger, et al. *Employing Commercial Satellite Communications: Wideband Investment Options for the Department of Defense.* Santa Monica, CA: RAND Corporation, 2000.

Brugioni, A. Dino. *Eyes in the Sky: Eisenhower, the CIA and Cold War Aerial Espionage*. Annapolis, MD: Naval Institute Press, 2010.

Corbett, Julian S. *Some Principles of Maritime Strategy*. Annapolis, MD: Naval Institute Press, 1988.

Debray, Regis. *Revolution in the Revolution? Armed Struggle and Political Struggle in Latin America*. New York, NY: Grove Press Inc., 1967.

Dockrill, Saki. *Eisenhower's New Look National Security Policy, 1953-61.* London: Macmillan Press, 1996.

Dolman, Everett C. *Astropolitik: Classic Geopolitics in the Space Age.* London: Frank Cass, 2002.

Dolman, Everett. *Pure Strategy: Power and Principle in the Space and Information Age*. New York, NY: Routledge, 2004.

Dornberger, Walter. *V-2.* Translated by James Cleugh and Geoffrey Halliday. New York, NY: The Viking Press, 1954.

Freedman, Lawrence. *Strategy: a history*. New York: NY, Oxford University Press, 2013.

Gladwell, Malcolm. *David and Goliath: Underdogs, Misfits, and the Art of Battling Giants*. New York, NY: Little, Brown and Company, 2013.

Guevara, Che. *Guerrilla Warfare*, 3rd ed. New York, NY: Scholarly Resources Books, 1997.

Haykin, Simon. *Communication systems*, 4th ed. New York: NY, John Wiley & Sons, 2001.

Hays, Peter L. *Space and Security*. Santa Barbara, CA: ABC-CLIO, 2011.

Holmes, Richard, ed. *The Oxford Companion to Military History*. New York, NY: Oxford University Press, 2001.

Ikenberry, G. John. *Liberal Leviathan: The Origins, Crisis, and Transformation of the American World Order*. Princeton, NJ: Princeton University Press, 2011.

Jervis, Robert. *Perception and Misperception in International Politics*. Princeton, NJ: Princeton University Press, 1976.

Jordan, David, James D. Kiras, David J. Lonsdale, Ian Speller, Christopher Tuck, and C. Dale Walton. *Understanding Modern Warfare*. New York, NY: Cambridge University Press, 2008.

Kalyvas, Stathis N. *The Logic of Violence in Civil War*. New York, NY: Cambridge University Press, 2009.

Kilcullen, David. *Out of the Mountains: The Coming Age of the Urban Guerrilla*. New York, NY: Oxford University Press, 2013.

Klein, John J. *Space Warfare: Strategy, Principles and Policy.* New York, NY: Routledge, 2006.

Kranz, Gene. *Failure is Not an Option: Mission Control from Mercury to Apollo 13 and Beyond.* New York: NY, Berkley Books, 2001.

Lawrence, T.E. *The Evolution of a Revolt.* Fort Leavenworth, KS: Combat Studies Institute Press, 2012. http://usacac.army.mil/cac2/cgsc/carl/download/csipubs/lawrence.pdf.

Liang, Qiao and Wang Xiangsui. *Unrestricted Warfare*. Beijing: PLA Literature and Arts Publishing House, February 1999.

McDougall, Walter A. *Heavens and the earth: a political history of the space age*. Baltimore, MD: Johns Hopkins University Press, 1985.

Miller, Roger G. *To Save a City: The Berlin Airlift, 1948-1949*. 2000. Reprint, College Station, TX: Texas A&M University Press, 2008.

Moltz, James Clay. *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 2nd ed. Stanford, CA: Stanford University Press, 2008.

Morgan, Forrest E. *Deterrence and First-Strike Stability in Space A Preliminary Assessment.* Santa Monica, CA: RAND Corporation, 2010.

Paret, Peter. "Clausewitz." In *Makers of Modern Strategy: from Machiavelli to the Nuclear Age,* edited by Peter Paret, Gordon A. Craig, and Felix Gilbert, 186-213. Princeton, NJ: Princeton University Press, 1986.

Olsen, John Andreas, ed. *A History of Air Warfare.* Washington, DC: Potomac Books, 2010.

Rid, Thomas. *Cyber War Will Not Take Place*. New York, NY: Oxford University Press, 2013.

Ridenour, L. et al. *Preliminary Design of an Experimental World-Circling Spaceship*. Santa Monica, CA: RAND Corporation, 1946. http://www.rand.org/pubs/special_memoranda/SM11827.html.

Sheehan, Michael. *The International Politics of Space.* New York, NY: Routledge, 2007.

Sherry, Michael S. *The Rise of American Air Power: The Creation of Armageddon*. New Haven, CT: Yale University Press, 1987.

Shimko, Keith L. *The Iraq Wars and America's Military Revolution.* New York, NY: Cambridge University Press, 2012.

Siddiqi, Asif A. *Sputnik and the Soviet Space Challenge*. Gainesville, FL: University Press of Florida, 2003.

Simpson, Emile. *War from the Ground Up: Twenty-First-Century Combat as Politics*. New York, NY: Oxford University Press, 2013.

Sledge, E. B. *With the Old Breed: At Peleliu and Okinawa.* New York, NY: Presidio Press, 2007.

Tangredi, Sam J. *Anti-Access Warfare: Countering A2/AD Strategies*. Annapolis, MD: Naval Institute Press, 2013.

Thucydides. *The Landmark Thucydides: A Comprehensive Guide to The Peloponnesian War*. Edited by Robert B. Strassler. Translated by Richard Crawley. New York, NY: Free Press, 1996. 2008.

Tse-Tung, Mao. "On protracted warfare." *Selected Works of Mao Tse-Tung*. Beijing: Foreign Language Press, 1967.

Tzu, Sun. *The Art of War*. Translated by Samuel B. Griffith. New York, NY: Oxford University Press, 1971.

Tzu, Sun. *The Illustrated Art of War*. Translated by Samuel B. Griffith. New York, NY: Oxford University Press, 2005.

Weigley, Russell F. *The American Way of War: A History of United States Military Strategy and Policy*. Bloomington, IN: Indiana University Press, 1973.

Worden, Simon P. and John E. Shaw. *Whither Space Power? Forging a Strategy for the New Century*. Maxwell AFB, AL: Air University Press, 2002.

Wright, David, Laura Grego, and Lisbeth Gronlund. *Physics of Space Security: A Reference Manual*. American Academy of Arts and Sciences. Cambridge MA, 2005.

Staff Studies

Air Force Space Command. *Resiliency and Disaggregated Space Architectures*. White Paper, 21 August 2013. http://www.afspc.af.mil/shared/media/document/AFD-130821-034.pdf.

Reports

Defense Atomic Support Agency. *Project Officer's Interim Report: STARFISH Prime*. Report ADA955694. Albuquerque, NM, August 1962.

Hoerlin, Herman. *United States High-Altitude Test Experiences: A Review Emphasizing the Impact on the Environment.* US Energy Research and Development Administration Report LA-6405. Los Alamos, NM: Los Alamos Scientific Laboratory, October 1976. http://www.fas.org/sgp/othergov/doe/lanl/docs1/00322994.pdf.

Sandia National Laboratories. *Did High-Altitude EMP Cause the Hawaiian Streetlight Incident?*, System Design and Assessment Note 31. Albuquerque, NM: Electromagnetic Applications Division, June 1989. http://ece-research.unm.edu/summa//notes/SDAN/0031.pdf.

Small Media. “SATELLITE JAMMING IN IRAN: A WAR OVER AIRWAVES.” A Small Media Report, November 2012. http://www-tc.pbs.org/wgbh/pages/frontline/tehranbureau/SatelliteJammingInIranSmallMedia.pdf.

United States Government Accountability Office. *Report to the Committee on Armed Services, U.S. Senate: DEFENSE SATELLITE COMMUNICATIONS DOD Needs Additional Information to Improve Procurements.* Washington, DC: General Accounting Office, July 2015. http://www.gao.gov/assets/680/671484.pdf.

Unpublished Papers

Snead, David Lindsey. "Eisenhower and the Gaither Report: The Influence of a Committee of Experts on National Security Policy in the Late 1950s." PhD diss., University of Virginia, January 1997.

Public Documents

Carter, President Jimmy. Presidential Directive/NSC-37. "National Space Policy." 11 May 1978. http://www.jimmycarterlibrary.gov/documents/pddirectives/pd37.pdf.

Department of Defense. *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014*. Washington, DC: Office of the Secretary of Defense, 24 April 2014.

Department of Defense and Office of the Director of National Intelligence. *National Security Space Strategy: Unclassified Summary*. Washington, DC: Secretary of Defense and Director of National Intelligence, January 2011.

Executive Office of the President, *A National Security Strategy for a New Century* (Washington, DC, The White House, December 1999), 12. http://clinton4.nara.gov/media/pdf/nssr-1299.pdf.

Executive Office of the President. *Deterrence & Survival in the Nuclear Age.* Washington, DC: Security Resources Panel of the Scientific Advisory Committee, 7 November 1957. http://nsarchive.gwu.edu/NSAEBB/NSAEBB139/nitze02.pdf.

Executive Office of the President. *National Space Policy of the United States of America.* Washington, DC: 28 June 2010. https://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.

Executive Office of the President. *NSC 5520*. Washington, DC: Executive Secretary, 11 October 1957. http://marshall.wpengine.com/wp-content/uploads/2013/09/NSC-5520-Statement-of-Policy-on-U.S.-Scientific-Satellite-Program-20-May-1955.pdf.

House. *2011 REPORT TO CONGRESS of the U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION*. 112th Cong., 1st sess., 9 November 2011. http://origin.www.uscc.gov/sites/default/files/annual_reports/annual_report_full_11.pdf.

House. *Professor Tom Humphreys, Statement on the Vulnerability of Civil Unmanned Aerial Vehicles and Other Systems to GPS Spoofing, Submitted to the Subcommittee on Oversight, Investigations, and Management of the House Committee on Homeland Security*. 112th Cong., 2nd sess., 18 July 2012. https://homeland.house.gov/files/Testimony-Humphreys.pdf.

Limited Test Ban Treaty of 1963, "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water," Bureau of Arms Control, Verification, and Compliance, 5 August 1963, http://www.state.gov/t/isn/4797.htm.

National Security Council Planning Board. National Security Council 5814/1. "Preliminary U.S. Policy on Outer Space." Dwight D. Eisenhower Presidential Library and Museum, 20 June 1958. http://marshall.wpengine.com/wp-

content/uploads/2013/09/NSC-5814-Preliminary-U.S.-Policy-on-Outer-Space-18-Aug-1958.pdf.

National Security Decision Directive-119. *Strategic Defense Initiative*. 16 May 1983. https://reaganlibrary.archives.gov/archives/reference/Scanned%20NSDDS/NSDD119.pdf.

National Security Decision Directive-172. *Presenting the Strategic Defense Initiative*. 30 May 1985. https://reaganlibrary.archives.gov/archives/reference/Scanned%20NSDDS/NSDD172.pdf.

National Security Directive-42. *National Space Policy*. 4 July 1982. https://reaganlibrary.archives.gov/archives/reference/Scanned%20NSDDS/NSDD42.pdf.

National Security Presidential Directive-49. *U.S. National Space Policy*. 31 August 2006. http://fas.org/irp/offdocs/nspd/space.pdf.

UN General Assembly. "Charter of the United Nations and Statute of the International Court of Justice." 26 June 1945. http://www.un.org/en/sections/un-charter/chapter-vii/.

UN General Assembly. Resolution 2222 (XXI). "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies." 19 December 1966. http://disarmament.un.org/treaties/t/outer_space/text.

United States Central Intelligence Agency. *The Soviet Atomic Energy Program*. National Intelligence Estimate Number 11-2A-62. Washington, DC: Director of Central Intelligence, 16 May 1962. http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000843187.pdf.

Memorandums

Bundy, McGeorge. National Security Action Memorandum-129. "U.S.-U.S.S.R. Cooperation in the Exploration of Space." 23 February 1962. http://marshall.wpengine.com/wp-content/uploads/2013/09/NSAM-129-U.S.-U.S.S.R.-Cooperation-in-the-Exploration-of-Space-23-Feb-1962-.pdf.

Bundy, McGeorge. National Security Action Memorandum-183. "Space Program for the United States." 27 Aug. 1962. http://marshall.wpengine.com/wp-content/uploads/2013/09/NSAM-183-Space-Program-for-the-United-States-27-Aug-1962.pdf.

Carter, President Jimmy. Presidential Review Memorandum/ NSC-23. "A Coherent U.S. Space Policy." 28 March 1977. http://marshall.wpengine.com/wp-content/uploads/2013/09/PRM-NSC-23-A-Coherent-Space-Policy-28-Mar-1977.pdf.

Johnson, President Lyndon B. National Security Action Memorandum-285. "Cooperation with the USSR on Outer Space Matters." 3 March 1964. http://www.lbjlib.utexas.edu/johnson/archives.hom/NSAMs/nsam285.asp.

Johnson, President Lyndon B. National Security Action Memorandum-384. "U.S. Cooperation with the European Launcher Development Organisation (ELDO)."

29 July 1966.
http://www.lbjlib.utexas.edu/johnson/archives.hom/NSAMs/nsam354.asp.
Kennedy, President John F. National Security Action Memorandum-271. "Cooperation with the USSR on Outer Space Matters." 12 Nov 63.
http://www.jfklibrary.org/Asset-Viewer/qVncp893wEmJFplIn1AlHA.aspx.
Kissinger, Henry A. National Security Action Memorandum-70. "International Space Cooperation: US-USSR Activities." 10 July 70.
http://www.nixonlibrary.gov/virtuallibrary/documents/nsdm/nsdm_070.pdf.
Kissinger, Henry A. National Security Action Memorandum-72. "Exchange of Technical Data between the United States and the International Space Community." 17 July 70.
http://www.nixonlibrary.gov/virtuallibrary/documents/nsdm/nsdm_072.pdf.
Kissinger, Henry A. National Security Action Memorandum-187. "International Space Cooperation – Technology and Launch Assistance." 30 Aug 72.
http://www.nixonlibrary.gov/virtuallibrary/documents/nsdm/nsdm_187.pdf.
Scowcroft, Brent. National Security Decision Memoranda-333. "Enhanced Survivability of Critical U.S. Military and Intelligence Space Systems." 7 July 1976.
https://www.fordlibrarymuseum.gov/library/document/0310/nsdm333.pdf.
Scowcroft, Brent. National Security Decision Memoranda-345. "U.S. Anti-Satellite Capabilities." 18 January 1977. http://marshall.wpengine.com/wp-content/uploads/2013/09/NSDM-345-U.S.-Anti-satellite-Capabilities-18-Jan-1977.pdf.

Doctrine Publications, Manuals, Instructions, Directives, and Others

Air Force Doctrine Document 1-02. *Air Force Supplement to the Department of Defense Dictionary of Military and Associated Terms*, 11 January 2007 Incorporating Change 1, 6 January 2012. https://fas.org/irp/doddir/usaf/afdd1-2.pdf.
Air Force Doctrine Document 2-2.1. *Counterspace Operations*, 2 August 2004. http://fas.org/irp/doddir/usaf/afdd2_2-1.pdf.

Sources Cited/Quoted in Another Source

Technological Capabilities Panel of the Science Advisory Committee. 1955. *Meeting the Threat of Surprise Attack, Vol. II* (Washington, D.C, February 14); cited in Peter Hays, *Space and Security*, Santa Barbara, CA: ABC-CLIO, 2011.

Minutes

Minutes. "A Day Without Space: Economic and National Security Ramifications with Ed Morris, Steven Anderson, Ronald Hatch, Dr. Peter Hays, Maj. Gen. James Armor (ret.), and Dr. John Sheldon" Conference. United States Chamber of Commerce, Washington, DC, 16 October 2008. http://marshall.org/wp-content/uploads/2013/08/Day-without-Space-Oct-16-2008.pdf.

Lectures and Addresses

Dolman, Everett. (comments at the Gathering of Space Theorists Debate, School of Advanced Air and Space Studies, Maxwell AFB, AL, 11 March 2016).

Kennedy, President John F. “Special message to the Congress on urgent national needs.” Address. Washington, DC, 25 May 1961. http://www.jfklibrary.org/Asset-Viewer/Archives/JFKPOF-034-030.aspx.

Maultsby, Tom, Aaron Q. Rogers, Lt Col Jason B. Mello. “Small Payload Launch Opportunities and Challenges.” Proceedings of the AIAA/USU Conference on Small Satellites, Technical Session I: All Systems Go!, 2015. http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3168&context=smallsat.

Ono, Kiyonobu, Takashi Fujimura, Toshiaki Ogawa, and Tsunekazu Kimura. “Small Sar Satellite Using Small Standard Bus.” Proceedings of the AIAA/USU Conference on Small Satellites, Technical Session I: Mission Payloads and their Applications, 2011. http://digitalcommons.usu.edu/smallsat/2011/all2011/11/.

Wilcoxson, Don. “Advanced Commercial Satellite Systems Technology for Protected Communication.” 2011 Military Communications Conference-Track 6-Department of Defense Programs, 2011. https://www.viasat.com/sites/default/files/legacy/Government%20satcom%20systems/AdvCommericalSatforProtectedComms.pdf.

Electronic Journals

Colby, Elbridge. “From Sanctuary to Battlefield: A Framework for a U.S. Defense and Deterrence Strategy for Space.” Center for a New American Security, 27 January 2016. http://www.cnas.org/sites/default/files/publications-pdf/CNAS%20Space%20Report_16107.pdf.

DeBlois, Lt Col Bruce M. “Space Sanctuary: A Viable National Strategy.” *Airpower Journal* (Winter, 1998). http://www.airpower.maxwell.af.mil/airchronicles/apj/apj98/win98/deblois.html.

Harrison, Roger G., Deron R. Jackson, and Collins G. Shackelford, “Space Deterrence: The Delicate Balance of Risk,” *Space and Defense* 3, no. 1 (Summer 2009): 17-26. http://www.usafa.edu/df/dfe/dfer/centers/ecsds/docs/Space_and_Defense_3_1.pdf.

Kessler, Donald J., and Burton G. Cour-Palais. "Collision frequency of artificial satellites: The creation of a debris belt." *Journal of Geophysical Research: Space Physics* 83, no. A6 (1978): 2637-2646. http://adsabs.harvard.edu/abs/1978JGR....83.2637K

Liddy, Major Lynda. “The Strategic Corporal: Some Requirements in Training and Education.” *Australian Army Journal* 2, no. 2 (Autumn 2005): 139-140. http://www.army.gov.au/~/media/army/our%20future/publications/aaj/2000s/2005/aaj_2005_2.pdf.

Mackey, Lt Col James. “Recent US and Chinese Antisatellite Activities.” *Air and Space Power Journal* 23, no. 3 (Fall 2009): 82-93. http://www.airpower.maxwell.af.mil/airchronicles/apj/apj09/fal09/fal09.pdf.

Moore, George M., Vic Budura and Joan Johnson-Freese. “Joint space doctrine: catapulting into the future,” *Joint Forces Quarterly*, (Summer 1994): 7.

Shelton, Gen William L. "Military Space: A Strategic Crossroad." *Air & Space Power Journal* (September-October 2013). http://www.airpower.maxwell.af.mil/digital/pdf/articles/2013-Sep-Oct/SLP-Shelton.pdf.

Teets, Honorable Peter B. Under Secretary of the Air Force. "National Security Space in the Twenty-First Century." *Air and Space Power Journal*, (Summer, 2004). www.airpower.maxwell.af.mil/airchronicles/apj/apj04/sum04/teets.html.

Electronic Articles

Axe, David. "Pentagon Preps for Orbital War With New Spaceplane." *The Daily Beast*, 3 August 2015. http://www.thedailybeast.com/articles/2015/08/03/pentagon-preps-for-orbital-war-with-new-space-plane.html.

Boeing. "X-37-B Orbital Test Vehicle." Boeing, accessed 26 April 2016. http://web.archive.org/web/20150321121050/http://www.boeing.com/boeing/defense-space/ic/sis/x37b_otv/x37b_otv.page.

Brandon, John. "Is Technology Making Us Less Human?" *Techradar*, 6 August 2013. http://www.techradar.com/us/news/world-of-tech/future-tech/is-technology-making-us-less-human--1171002/2.

David, Leonard. "Secret X-37B Space Plane Has Changed Orbit," *Space.com*, 24 August 2010. http://www.space.com/9000-secret-37b-space-plane-changed-orbit.html.

European Space Agency. "Copernicus Observing the Earth." ESA.int, accessed 15 April 2016. http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Contributing_Missions_overview.

Fallows, James. "The Coming Age of Space Colonization." *The Atlantic*, 20 March 2013. http://www.theatlantic.com/technology/archive/2013/03/the-coming-age-of-space-colonization/273818/.

Ferster, Warren and Colin Clark. "NRO Confirms Chinese Laser Test Illuminated U.S. Spacecraft." *SpaceNews*, 3 October 2006. http://www.spacenews.com/article/nro-confirms-chinese-laser-test-illuminated-us-spacecraft.

Freedberg, Sydney J. "US Jammed Own Satellites 261 times; What If Enemy Did?" Breaking Defense, 2 December 2015. http://breakingdefense.com/2015/12/us-jammed-own-satellites-261-times-in-2015-what-if-an-enemy-tried/.

Gertz, Bill. "China, Russia Planning Space Attacks on U.S. Satellites." *The Washington Free Beacon*, 16 March 2016. http://freebeacon.com/national-security/china-russia-planning-space-attacks-on-u-s-satellites/.

GPS World staff. "Draganfly UAS now use GPS + GLONASS." *GPS World*, 27 April 2016. http://gpsworld.com/draganfly-uas-now-use-gps-glonass/.

Gruss, Mike. "U.S. Air Force Declares GSSAP Surveillance Sats Operational." *SpaceNews*, 8 October 2015. http://spacenews.com/u-s-air-force-declares-gssap-surveillance-sats-operational/.

Howell, Elizabeth. "XS-1: DARPA's Experimental Spaceplane." *Space.com*, 1 May 2015. http://www.space.com/29287-xs1-experimental-

spaceplane.html?adbid=10152809779056466&adbpl=fb&adbpr=17610706465&cmpid=514630_20150514_45741516&short_code=2zjo7.

Kaufman, Marc and Dafna Linzer. “China Criticized for Anti-Satellite Missile Test.” *The Washington Post*, 19 January 2007. http://www.washingtonpost.com/wp-dyn/content/article/2007/01/18/AR2007011801029.html.

Kaufman, Marc and Josh White. “Spy Satellite's Downing Shows a New U.S. Weapon Capability.” *The Washington Post*, February 22, 2008. http://www.washingtonpost.com/wp-dyn/content/article/2008/02/21/AR2008022100641.html.

Kelly, Michael S. “Airborne Launch Assist Space Access (ALASA).” Defense Advanced Research Projects Agency, accessed 15 April 2016. http://www.darpa.mil/program/airborne-launch-assist-space-access.

Mark, Joshua J. “War.” Ancient History Encyclopedia, 2 September 2009. http://www.ancient.eu/war.

Munroe, Tony and Jack Kim. “U.S. flies B-52 over South Korea after North's nuclear test.” *Reuters*, 10 January 2016. http://www.reuters.com/article/us-northkorea-nuclear-idUSKCN0UN0Y420160111.

National Coordination Office for Space-Based Positioning, Navigation, and Timing. “Fiscal Year 2015 Program Funding.” GPS.gov, 30 December 2014. http://www.gps.gov/policy/funding/2015/.

National Space Society. “Space Solar Power Limitless Clean Energy From Space.” *National Space Society*, 11 April 2016. http://www.nss.org/settlement/ssp/.

News.com.au. “US military's top secret X-37B shuttle 'disappears' for two weeks, changes orbit.” *News.com.au*, 25 August 2010. http://www.news.com.au/technology/us-militarys-top-secret-x-37b-shuttle-disappears-for-two-weeks-changes-orbit/story-e6frfro0-1225909738276.

Pannell, Ian. “Syria civilians still under chemical attack.” *BBC News*, 10 September 2015. http://www.bbc.com/news/world-middle-east-34212324.

Pham, Nam D. “The Economic Benefits of Commercial GPS Use in the U.S. and The Costs of Potential Disruption.” June 2011. http://saveourgps.org/pdf/GPS-Report-June-22-2011.pdf.

Planet Labs, “About,” Planet Labs, accessed 15 April 2016, https://www.planet.com/about/#approach.

Schultz, Teri and Wendell Goler. “Military Wipes Out Iraqi GPS Jammers.” *Fox News*, 25 March 2003. http://www.foxnews.com/story/2003/03/25/military-wipes-out-iraqi-gps-jammers.html.

Selding, Peter B. de. “China Official: Beidou Will Receive GPS, Glonass, Galileo, Signals.” *SpaceNews*, 6 February 2015. http://spacenews.com/china-official-beidou-gear-will-receive-u-s-russian-and-european-gnss-signals/.

Selding, Peter B. de. “Eutelsat Blames Ethiopia as Jamming Incidents Triple.” *SpaceNews*, 6 June 6 2014. http://spacenews.com/40818eutelsat-blames-ethiopia-as-jamming-incidents-triple/.

Soares, Marcelo. “The Great Brazilian Sat-Hack Crackdown.” *WIRED*, 20 April 2009. http://www.wired.com/2009/04/fleetcom/.

Sputnik News. “Invisible warfare: Russia touts second-to-none jamming equipment.” *Sputnik News*, 7 March 2016.

http://sputniknews.com/russia/20160307/1035897115/russia-electronic-warfare-systems.html.

Technology Quarterly Q2 2014. "Nanosats are go!" *Economist*, 7 June 2014. http://www.economist.com/news/technology-quarterly/21603240-small-satellites-taking-advantage-smartphones-and-other-consumer-technologies.

United States Air Force. "X-37B Orbital Test Vehicle." United States Air Force, 17 April 2015. http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104539/x-37b-orbital-test-vehicle.aspx.

Weeden, Brian. "Dancing in the dark redux: Recent Russian rendezvous and proximity operations in space." *The Space Review,* 5 October 2015. http://www.thespacereview.com/article/2839/1.